9098

U.S. Army Environmental Center

Phase II Site Investigations Report Volume III of III Appendices

Fort Devens Sudbury Training Annex, Massachusetts

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AEC Form 45, 1 Feb 93 replaces THAMA Form 45 which is obsolete.

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APPENDIX A

BORE LOGS

APPENDIX A

BORE LOGS

Appendix A contains field bore logs for all boreholes drilled during Ecology and Environment, Inc.'s performance of environmental investigations at the Sudbury Annex. Please refer to Section 5.1.3 of Volume I for a description of borehole drilling and abandonment procedures. The bore logs are arranged by watershed. Please note that no boreholes were drilled in Watersheds 1B, 3, or 4.

WATERSHED 1A

Boreholes:

E3-P06-B01
E3-P06-B02
E3-P06-B03

BORING LOG GENERAL DATA
Borehole Number: E3-P06-B01
Page: 2 of
Signature:
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Date Sent:

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Project: SUDBURY ANNEX

Boring: E3-P06-B01

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8/4/93

START/FINISH - 1600/1650

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
GROUND SURFACE					
0		SS1 Dark Br silty sand grading to light BROWN FN GR SAND, DRY HOMOGENEOUS	1601 R=1.0	2, 2, 2, 6	NOTE 1/SPLIT SPOONS DRIVEN W/140LB HAMMER W/30" FREE FALL 2/DEPTHS IN FEET 3/4¼" HSA 4/2"x2' SPLIT SPOON ~~5/BELOW~~
		OVA 0.0			
2					
4		SS2 DRY BROWN FN GR SANDY SILT CONTACT W/DRY LT TAN FN GR SAND @ 4.5' 10ppm OVA at THE CONTACT. LT TAN SAND IS HOMOGENEOUS LOOSE	1630 R=1.0	4, 5, 5, 5	
		OVA 10 ppm — 1 ppm			DRILLING NOTES
6			1636		1/DRIVE 2 SPLIT SPOONS 0-2'
9		SS3 LT TAN FN GRAIN SILTY SAND HOMOGENOUS, TIGHT, WET AT 10'. SOME Fe STAINING	1650 R-1.4	3, 4, 4, 3	2/AUGER TO 4' 3/DRIVE SPLSP 4-6 4/AUGER TO 9' 5/DRIVE SPLIT SP 9-11' 6/H_2O @ 10' 7/GROUT BOREHOLE 9' — 0' SURFACE
11					
		TD = 9'			

SAMPLES COLLECTED
0-2' BXCG0101
4-6 BXCG0102

usagndat.pm4

Project: SUDBURY ANNEX

Boring: E3 P6 · B02

Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/5/93 Soil/Rock Description START/FINISH - 0946/1008 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		SS1 TOP .4' HUMUS-BROWN GRADING TO BROWN YELLOW SILTY SAND. .4'-2' YELLOW-TAN-FNGR SAND HOMOGENEOUS, DRY LOOSE OVA= 0.0 ppm	0947 R=1.2	3 3 3 3	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL 2/ DEPTH & R IN FEET 3/ 4 1/4" HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		SS2 - MOIST, YELLOW-TAN FNGRAINED SAND, HOMOGENOUS, BECOMING WET @ 5.5'	0953 R=1.7	4 3 4 4	
	▽				DRILLING NOTES: 1/ DRIVE SPL.SP. 0-2' 2/ AUGER TO 4' 3/ DR SPL SP 4-6' 4/ H_2O @ 5.5' 5/ TD - 4.0' AUGER 6/ GROUT 4' TO SURFACE
6					
9			R=		
11					SAMPLES TAKEN 0-2' - BX060201 4-6' - BX060202

BORING LOG GENERAL DATA
Borehole Number: E3-P6-B02
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Project: SUDBURY ANNEX

Boring: E3-P6-B03

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Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		8/5/93 START/FINISH — 1015/1040 GROUND SURFACE			
		SS1 ~~TOP~~ 0.3' DK BR HUMUS, DRY. 0.3 → 2' LT BR FN GR SND GRADING TO YELLOW TAN FN GR SAND. HOMOGENEOUS, LOOSE 0.0 ppm OVA	1016 R=1.2	2 2 2 2	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL 2/ DEPTH & R IN FEET 3/ HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		SS2 MOIST MED→CS SAND LT BROWN NO FINES FN/MED/CS 20/50/30 BECOMING WET @ 4.5 ~~5.0~~ TWG MINOR SUBROUNDED GRAVEL < 5% (< 5 mm) diameter $H_2O \simeq 4.5'$ OVA = 0.5 ppm	1026 R=1.6	3 3 3 4	
5	∇				
6		TD: 4.0'			DRILLING NOTES 1/ DRIVE SPL SP 0-2' 2/ AUGER TO 4' 3/ DR SPL SP 4-6 4/ H_2O @ $\simeq$ 5.0' 5/ REMOVE HSAs 6/ GROUT B11 - 4' - 0
			R		
					SAMPLES 0-2' BX060301 4-6 BX060302

BORING LOG GENERAL DATA
Borehole Number: E3-P6-B03
Page: 2 of
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WATERSHED 2

Boreholes:

E3-A12-B01
E3-A12-B02
E3-A12-B03
E3-A12-B04
E3-P28-B01
E3-P28-B02
E3-P28-B03
E3-P28-B04
E3-P28-B05
E3-P28-B06
E3-P36-B01
E3-P36-B02
E3-P36-B03
E3-P37-B01
E3-P37-B02
E3-P37-B03
E3-P38-B01
E3-P38-B02 (power auger)
E3-P38-B03 (power auger)
E3-P48-B01
E3-P48-B02
E3-P48-B03

Project: SUDBURY ANNEX

Boring: E3-A12-B01

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Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description 3/11/93 START/FINISH - 1200/1312 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-.5 - DK BROWN SILTY SAND .5-2' - ORANGE BR - FN GRAINED SND W/ MINOR GRAVEL, SUBROUNDED PHYLLITES, GRANODIORITE QTZITES LOOSE, MOIST.	SS1 1201 R=1.4	1 4 4 4	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREE FALL 2/ DEPTH & R IN FEET 3/ 4 1/4 HSAs 4/ 2" X 2' SPLIT SPOONS
4		4-4.2 TAN FN-MD GR SAND W/ GRAVEL FN/MD = 70/30 GRAVEL = [illegible] 4.2-4.4 = MD CSGRAIN SND W/ GRAVEL, DK BROWN STAINING 4.4-4.6 - LT BROWN FN GR SND, MINOR GRAVEL 4.6-6.0 - MD GRAVELLY SND, GRAVEL SUBROUNDED QTZITE PHYLLITE, GRANODIORITE MOIST, SOME STAINING. FN/MD/CS = 20/70/10 SND/GRAVEL = 80/20%	SS2 1233 R=	6 9 14 23	
6					DRILLING NOTES 1/ DRIVE SPL SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPL SP 4-6' 4/ AUGER TO 9' 5/ DRIVE SPL SP 9-11' 6/ H_2O @ 10' 7/ REMOVE HSAs 8/ GROUT BH 9-SURFACE. TD = 9'
9	▽	$H_2O \approx 10'$ VERY MOIST BROWN SILT W/ WEATHERED GRAVEL, FE STAINING, TIGHT, TILL GRAVEL WEATHERED PHYLLITE, GRANODIORITE, QTZITES ~~[illegible]~~ MORE CLAY AT BOTTOM OF SPOON.	SS3 1444 R=1.3	44 40 23 19	
11					SAMPLES 4-6' = BX120101 (SAMPLE & DUPLICATE) 9-11' = BX120102

BORING LOG GENERAL DATA Borehole Number: E3-A12-B01 Page: 2 of Signature: [illegible] Sent to USATHAMA: Date Sent:

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Project: SUDBURY ANNEX

Boring: E3 A12-B02

Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (8/11/93; START/FINISH-0812/0900; GROUND SURFACE)	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		LT BR SILTY SND DRY, LOOSE -	SS1 0813 R=.5	6 15 12 7	NOTE: 1/SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL
2		OVA 0.0 ppm			2/DEPTH & R IN FEET
4		TAN, MOIST FN GRAINED SAND HOMOGENEOUS BECOMING CORSER @ 5.8' - FN/MD = 60/40 W/SUBROUNDED GRAVELS OF PHYLLITE GRANODIORITE, QTZITES	SS2 0823 R=1.5	4 4 7 7	3/4¼" HSAs 4/2" X 2' SPLIT SPOONS
6		OVA=0.0 ppm			DRILLING NOTES: 1/DRIVE SPLIT SP 0-2' 2/AUGER TO 4' 3/DRIVE SPL SP 4-6'
9		H_2O ≈ 10' TIGHT, BR MOIST, CLAYEY SILT W/WEATHERED GRAVEL OF GRANODIORITE, QZITE, PHYLLITE. ~~FIGHTING~~ TILL	SS3 0843 R=1.9	24 33 77 68	4/AUGER TO 9' 5/DRIVE SPL SP 9-11'
11	▽	OVA=0.0 ppm			6/ H_2O @ ≈ 11' 7/REMOVE HSAs 8/GROUT BH 9' to SURF
14		TD 9'			9/TD 9'
16					

SAMPLES

4-6' BX120201

9-11 BX120202

BORING LOG GENERAL DATA

Borehole Number: E3-A12-B02

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Project: SUDBURY ANNEX

Boring: E3-A12-B03

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Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/10/93 Soil/Rock Description START/FINISH-1604 / 1707 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		MOIST, LT BROWN SANDY SILT W/ GRAVEL, SUBROUNDED QTZITE, PHYLLITE & GRANODIORITE SOME FE STAINS. OVA=0.0 ppm	1604 R=1.7	6 5 9 12	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL 2/ DEPTH & R IN FEET 3/ 4 1/4 HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		100% SANDY SILT AS ABOVE OVA 0.0 PPM	1620 R=.9	7 4 9 19	DRILLING NOTES: 1/ DRIVE SPLIT SP 0-2 2/ AUGER TO 4' 3/ DR SPL SP 4-6' 4/ AUGER TO 9' 5/ DRIVE SPLIT SP 9-11' 6/ AUGER TO 14 7/ H2O @ 13' 8/ DRIVE SPLIT SP 14-16' 9/ REMOVE AUGERS 10/ POUR GROUT 14 → SURFACE
6					
9		BROWN, MOIST SANDY SILT W/ WEATHERED GRAVEL, QTZITES, PHYLLITE GRANODIORITE. TIGHT, SAND IS FN GR TILL OVA = 0.0 PPM	1634 R=1.5	20 25 29 33	
11	▽	H_2O @ 13'	1653		
14		BROWN, WET CLAYEY SILT W/ WEATHERED GRAVEL OF PHYLLITE, QTZITE, GRANODIORITE = TILL OVA = 0.0 ppm	R=1.6	9 12 25 26	
16					SAMPLES 9-11' - BX120301 14-16 BX120302

BOF 3 LOG GENERAL DATA Page: 2 of
Borehole Number: E3-A12-B03 Signature: [signature] Sent to USATHAMA: Date Sent:
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BC...NG LOG GENERAL DATA
Borehole Number: E3-A12-B04

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Project: SUDBURY ANNEX

Boring: E3-A12-B04

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Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		8/11/93 START/FINISH-1350/1430 GROUND SURFACE			
		LT BR, DRY, LOOSE, SILT W/SAND & MINOR GRAVEL. GRAVEL SUBANGULAR → SUBROUNDED QTZITE PHYLLITES & GRANODIORITE	SS1 1351 R=.3'	1 2 2 3	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL 2/ DEPTH & R IN FEET 3/ 4¼" HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		4-5.5 - TAN, FN GRAINED SAND DRY, LOOSE. 5.5-6.0 - LT BROWN SILTY SAND W/MINOR SUBROUNDED GRAVEL. SLIGHTLY MOIST, ~~MORE~~ MORE COHESIVE THAN SAND ABOVE	SS2 1405 R=1.4	1 2 4 10	DRILLING NOTES 1/ DRIVE SPLIT SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPL. SP 4-6'
6					
		$H_2O \simeq 10'$			
9	▽	LT BROWN, MOIST → WET CLAYEY SILT W/WEATHERED GRAVEL OF QTZITE GRANODIORITE, PHYLLITES, SILT IS TIGHT, ~~PLASTI~~ SEMI PLASTIC	1416 R=1.3'	11 17 37 24	4/ AUGER TO 9' 5/ DRIVE SPL SP 9-11' 6/ H_2O @ ≃ 10' 9/ REMOVE HSAs 10/ GROUT HOLE 9-SURF 11/ TD = 9'
11					
		TD = 9'			SAMPLES 4-6 - BX120401 9-11 - BX120402

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BORING LOG GENERAL DATA
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Project: SUDBURY ANNEX

Boring: E3-P28-B01

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8/9/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
		0.0-0.5 Dark Brown fine to med. silty sand (~30% F) with some fine to med pebbles	2	
		0.5-2.0 Tan to Gray med to cs ~~sand~~ silty sand (~20% F) with ~15% fine to med pebbles and some mica flakes.	5	SS-1
			11	
			13	
			R=1.5	
2		2.0-4.0 Med. Brown med to cs silty sand w/ ~20% F and ~15% fine to med pebbles and mica flakes. Minor (1/4") organic layers		
4		4.0-5.5 Gray and Tan med to coarse clean sand (<10% F) with fine to med pebbles.	SS-2	8
		5.5-6.0 Tan fine to med silty sand (~30% F) slightly damp.	D=3.0"	10
			R=1.5	12
				13
6		6.0-9.0 SAA with ~10% cs quartz sand and phyllite grains. Increasing fines with depth (to ~40% F).		
7.5	▽			
		TD BH		
9		9.0-11.0 SAA, increasing fines to about ~~60%~~ 75% F. Some fine to med pebbles in first 8".	SS-3	4
				3
				2
				1
				R=2.0
11				

Drilling Data

START/FINISH - 0917/1005

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2) DEPTH AND RECOVERY IN FEET.
3) 4.25 INCH DIA. HOLLOW STEM AUGERS
4) 2 INCH X 2 FEET SPLIT SPOONS - UNLESS OTHERWISE NOTED (i.e. D=3.0")

DRILLING NOTES

1) DRIVE SPL SP 0-2
2) AUGER TO 4'
3) DRIVE SPL SP 4-6'
4) AUGER TO 9' (TD)
5) DRIVE SPL SP 9-11'
H_2O @ 7.5'
6) GROUT 9' - SURF

SAMPLES

4-6 BX280101
9-11 BX280102

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BORING LOG GENERAL DATA
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8/9/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE: ORGANICS			START / FINISH - 1015/1130
		0.0-0.5 Dark Brown fine to med silty sand, ~60% F with some fine to med pebbles.	SS-1	3	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
		0.5-2.0 Light gray med to cs silty sand w ~20% F and med to cs pebbles		10	
				10	
				12	
2				R=0.6	
		2.0-4.0 Tan to Med Brown med to cs silty sand with ~20% fine to med pebbles, ~20% F			2) DEPTH AND RECOVERY IN FEET.
4		4.0-6.0 Tan to Gray med to cs silty sand (~20% F) with ~20% fine to med pebbles.	SS-2	5	3) 4.25 INCH DIA. HOLLOW STEM AUGERS
				13	
				13	
				14	
6		6.0-9.0 SAA coarsens with depth wet at 7.5' BGS.		R=1.0	4) 2 INCH X 2 FEET SPLIT SPOONS
7.5	▽				
		TD BH			
9		9.0-11.0 Gray med to coarse silty sand w/ ~15% F and ~15% fine to med pebbles. Wet. Some iron staining in ½" layers and on some grains.	SS-3	3	
				7	
				7	
				12	
11				R=1.5	

DRILLING NOTES
1) DRIVE SPL SP 0-2'
2) AUGER TO 4'
3) DRIVE SPL SP 4-6
4) AUGER TO 9' (TD)
5) DRIVE SPL SP 9-11
H_2O @ 7.5'

SAMPLES
4-6 BX280201
9-11 BX280202

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Project: SUDBURY ANNEX

Boring: E3-P28-303

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8/9/93

GROUND SURFACE ORGANICS

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
0–2		0.0-2.0 Medium Brown, fine to med silty sand (~20% F) with some fine to med pebbles.	SS-1	4, 6, 14, 13, R=0.2	START / FINISH - 1301-1355
2–4		2.0-4.0 SAA			
4–6		4.0-4.25 Gray med to cs to v.cs clean sand. 4.25-6.0 Light Gray fine to med silty sand (~25% F).	SS-2	4, 7, 5, 7, R=1.0	
6–9 (7.5 ▽)	▽	6.0-9.0 Light to med. Brown fine to med. silty sand (~25% F). Coarsens with depth. TD Bit			
9–11		9.0-11.0 Med Brown to gray-brown fine to med silty sand (~30% F) with some fine phyllite pebbles	SS-3	2, 3, 4, 4, R=1.5	

Drilling Data:

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2) DEPTH AND RECOVERY IN FEET.
3) 4.25 INCH DIA. HOLLOW STEM AUGERS
4) 2 INCH X 2 FEET SPLIT SPOONS

DRILLING NOTES

1) DRIVE SPL SP 0-2'
2) AUGER TO 4'
3) DR SPL SP 4-6'
4) AUGER TO 9'
5) DRIVE SPL SP 9-11'

H_2O @ ≈ 7.5'

SAMPLES

4-6 BX280301

9-11 BX280302

BORING LOG GENERAL DATA

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Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE ORGANICS		
		0.0-0.5 Light Brown fine to med silty sand with 50% F and fine to med pebbles. 0.5-2.0 Tan fine to med silty sand with ~20% and ~20% v. cs sand grains and mica flakes	SS-1	2, 7, 9, 12, R=1.0
2		2.0-4.0 SAA with Tan to Med Brown colour.		
4		4.0-6.0 Tan to Gray medium to cs silty sand (~15% F) with fine to med pebbles of qtz and phyllite, some mica flakes. damp.	SS-2	7, 7, 8, 9, R=1.25
6		6.0-9.0 SAA		
8	▽			
9		TD BH		
		9.0-11.0 Gray fine to med silty sand with 2" cs sand and fine to med pebble layers of qtz and phyllite.		3, 6, 7, 6, R=1.5
11				

Drilling Data

START | FINISH-1412-1522

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2) DEPTH AND RECOVERY IN FEET.
3) 4.25 INCH DIA. HOLLOW STEM AUGERS
4) 2 INCH X 2 FEET SPLIT SPOONS

DRILLING NOTES

1) DRIVE SPL SP 0-2
2) AUGER TO 4'
3) DRIVE SPL SP 4-6'
4) AUGER TO 9' (TD)
5) DRIVE SPL SP 9-11

H_2O @ 7.5'

SAMPLES

4-6 BX280401
9-11 BX280402

usagndat.pm4

Project: SUDBURY ANNEX

Boring: E3-P22-B05

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8/9/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE ORGANICS		
		0.0 - 0.5 Light Tan fine to med silty sand (~60% F) with ~15% pebbles. 0.5 - 2.0 Med. Brown fine to med silty sand w/ some cs sand grains and some fine pebbles	SS-1	1 / 5 / 10 / 10 / R=0.5
2		2.0 - 4.0 SAA - Note a 3" thick layer of v.cs pebbles at 3.0' BGS - well rounded, mostly qtz and phyllite.		
4		No recovery	SS-2	18 / 23 / 50 / 57 / R=Ø
6		6.0 - 8.0 Tan to gray, med to cs clean sand with 25-30% med pebbles of qtz and phyllite, some iron staining on grains.	SS-3	9 / 9 / 12 / 9 / R=1.25
8		8.0 - 9.0 SAA, very damp. TD BH		
9	▽	9.0 - 9.5 SAA, wet. 9.5 - 10.5 Gray, fine to med silty sand (~30% fines) wet. 10.5 - 11.0 Tan to gray as 6.0 - 8.0 wet.	SS-4	1 / 3 / 5 / 6 / R=1.5
11				

Drilling Data

START | FINISH - 1633 | 1715

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.

2) DEPTH AND RECOVERY IN FEET.

3) INCH DIA. HOLLOW STEM AUGERS

4) 2 INCH X 2 FEET SPLIT SPOONS

DRILLING NOTES

1) DRIVE SPL SP 0-2'
2) AUGER TO 4'
3) DRIVE SPL SP 4-6
4) AUGER TO 9' (TD)
5) DRIVE SPL SP 9-11'
H_2O @ 9'

SAMPLES

6-8 BX280501
9-11 BX280502

BORING LOG GENERAL DATA
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BORING LOG GENERAL DATA
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8/10/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
0–2		0-0.1' silty sand - dk brn, low moisture 50% F, 40% M 10% coarse, organics and some small gravels <1/8" diam present. 0.1-0.8' silty sand as above except med-lt brn w/ large gravel (1" diam) at 0.6'	SS1 OVA = 0 ppm	3, 8 10, 14 0.8'R
2–4		Sand as above - slightly coarser w/ depth		
4–6		Silty Sand - lt. brn., low moisture ~~40%~~ 50% M 50% C, very few fines <5% silt, some iron staining, some gravels up to 1/2" diam	SS2 OVA = 0 ppm	8, 13, 13, 14 1.2'R
6–9		Sand as above wet at ≅ 8 ft		
9–11		Silty Sand - lt. brn, wet; 30% M, 70% C very few fines, <5% silt; 10-15% gravels up to 1/4" diam	SS3 OVA = 0 ppm	2, 4, 8, 6
		TD = 9'		

Drilling Data
Time Start 0849
Time Stop 0922

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2) DEPTH AND RECOVERY IN FEET.
3) 4 1/4 INCH DIA. HOLLOW STEM AUGERS
4) 2 INCH X 2 FEET SPLIT SPOONS.

DRILLING NOTES
1) DRIVE SPLIT SP 0-2
2) AUGER TD 4'
3) DRIVE SPL SP 4-6
4) AUGER TD 9'
5) DR SPL SP 9-11'
H_2O @ 8'

SAMPLES
4-6 BX280601
9-11 BX280602

BORING LOG GENERAL DATA
Borehole Number: E3-P36-B01
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Sent to USATHAMA:
Date Sent:
Xerox

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Project: Sudbury Annex

Boring: E3-P36-B01

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8/5/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data Start Time: 0943 Stop Time: 1115
		GROUND SURFACE 3" Asphalt			
0		0-0.6' - Silty Sand; med brn; low moisture 40% F, 60% M; 20-30% silt; 20-25% subangular gravels up to 1/4" diam some organics 0.6-1.2' - Silty Sand, lt. brn, 40% F, 60% M; some gravels; low organics; large cobble at bottom of SS	SS1 OVA=0ppm	15, 15, 30, 66 1.2'R	OVA=2ppm downhole 1) Split Spoons Driven w/140 lb hammer w/30" Freefall 2) Depth + R in ft 3) 4 1/4 HSAs 4) 2" x 2' split spoons
2		Sand as above - except gravels increasing in size to 1 1/2" diam			
4		Clayey Sand; med brn; moist; 40% F, 60% M; 10-20% clay; some small gravels; large cobble at 4.5'	SS2 OVA=0ppm	6, 25, 26, 24 1.0'R	DRILLING NOTES
6		6.0-6.5' Sand as above 6.5-7.0' Sand as above except 10-20% weathered bedrock; large mica flakes	SS3 OVA=0ppm	4, 6, 29, 32 1.0'R	1) DRIVE SPL SP 0-2' 2) AUGER TO 4' 3) DRIVE SPL SP 4-6
8		Sand as above - large cobbles of mica schist			4) DRIVE SPL SP 6-8 HOMOGENIZE THE SAMPLES 4) AUGER TO 9' 5) DRIVE SPL SP 9-11' 6) AUGER TO 14' TD
9		Silty Sand - gray brown; high moisture at 9.6'; 40% F, 60% M; coarser w/ depth; 10-20% subangular gravels; iron staining throughout; large granite cobble at bottom of spoon	SS4 OVA=0ppm	13, 25, 36, 35 1.2'R	7) DRIVE SPL SP 14-16 H_2O @ 14'
11		Rough Augering Encountered 11-12' Large Cobbles up to 4" diam			
14	Δ	14-14.5' Silty Sand, wet, 20% F, 40% M, 40% C, some clay and iron staining 14.5-15.0' Gravelly Sand; wet; 40% M, 60% C; gravels up to 1/4" diam throughout	SS5 OVA=0ppm	14, 35, 74, - 1.0'R	SS refusal at 15.3'
16		TD = 16'			SAMPLES 4-6 BX360101 14-16 BX360102

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BORING LOG GENERAL DATA
Borehole Number: E3-P36-B02
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Project: SUDBURY ANNEX

Boring: E3 P36-B02

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8/5/93

START | FINISH - 1255/1405

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
		SS1 LT BROWN SILT GRADING TO A DRY YELLOW BR SILTY FN GR SAND	1259 R=.8'	4 5 6 10
		OVA - 0.0 ppm		
2				
4		SS2 DRY TAN ~~FN~~ SILT W/ FINE GR SND, GRAVEL & ROCK, HEAVILY WEATHERED, & FRIABLE, OTHER GRAVEL SUBROUNDED. GRAVEL = GRANODIORITE, QTZITE TILL	1304 R 1.8	26 38 36 41
6				
9		SS3 MOIST TAN SILT W/ WEATHERED GRAVEL AS ABOVE. BECOMING WET @ 10'.	1317 R 1.8	18 15 14 10
	▽			
		OVA = 0.0 ppm		
11		H_2O @ ≈ 10'		
11		SS4 WET TILL AS ABOVE IRON BANDS @ ≈ 12.5'/12.7'	1339 R-1.6	15 16 27 31
		OVA = 0.0 ppm		
13				

Drilling Data

NOTE:
1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL
2/ DEPTH & R IN FEET
3/ HSAs
4/ 2" X 2' SPLIT SPOONS

DRILLING NOTES
1/ DRIVE SPLITSPOON 0-2'
2/ AUGER TO 4'
3/ DR SPL SPOON 4-6'
4/ AUGER TO 9'
5/ DRIVE SPL.SP 9-11'
6/ H_2O @ ≈ 10'
7/ DRIVE SPLITSPOON 11-13'
8/ PULL AUGERS
9/ GROUT 9'-SURFACE

SAMPLES
4-6' BX360201
9-11 BX360201 VOC
11-13 COMPOSITED W/ ABOVE FOR OTHER SAMPLES

usagodat.pm4

BORING LOG GENERAL DATA
Borehole Number: E3-P36-30

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Project: SUDBURY ANNEX | Boring: E3-P36-303 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE ORGANICS			8/13/93 START / FINISH - 1430 / 1600
		0.0 - 2.0 Dark Brown to orange-tan fine to med. silty sand (~60% F) Some organics. ~10% clay		1 / 2 / 2 / 2 / R=0.8	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2		2.0 - 4.0 Orange-tan fine to med. silty sand (~60% F) with ~15% Clay			2) DEPTH AND RECOVERY IN FEET.
4		4.0 - 6.0 Tan to gray fine to med. silty sand with ~20% clay and fine to cs pebbles.		18 / 28 / 30 / 32 / R=1.5	3) INCH DIA. HOLLOW STEM AUGERS 4) 2 INCH X 2 FEET SPLIT SPOONS
6		6.0 - 9.0 SAA			DRILLING NOTES 1) DRIVE SPL SP 0-2
		TD BH			2) AUGER TO 9'
9		9.0 - 11.0 Tan to gray fine to cs silty sand (~40% F) with ½" iron stained bands. slightly cohesive. wet.		18 / 25 / 24 / 20 / R=1.3	3) DRIVE SPL SP 4-6 4) AUGER TO 9' (TD) 5) DRIVE SPL SP 9-11'
10	▽				H_2O @ = 10.0'
11					

SAMPLES
4-6 BX360301
9-11 BX360302

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recycled paper

ecology and environment

usagudat.pm4

BORING LOG GENERAL DATA
Borehole Number: E3-P37-B01
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Date Sent:
Xerox:
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Project: SUDBURY ANNEX | Boring: E3-P37-B01 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (8/9/93; START/FINISH - 1145/1233; GROUND SURFACE)	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-.2' BR SANDY SOIL W/ ROOTS .2-2' SLIGHTLY MOIST BROWN MED/CS GRAIN SAND W/GRAVEL, SUBROUNDED QTZITE, PHYLLITE, GRANODIORITES FN/MD/CS (SAND) = 10/50/40 OVA=0.0ppm	SS1 1145 R=1.8	4 7 6 5	NOTE 1/ SPLIT SPOONS DRIVEN W/ 140LB HAMMER W/ 30" FREE FALL. 2/ DEPTH & "R" IN FEET 3/ 4 1/4" HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		4-5.0. MOIST, TAN, LOOSE MD/CS GR SAND W/GRAVEL SUBROUNDED QTZ PHYLLITE, GRANODIORITES SND/GRAVEL 90/10 INCREASING GRAVEL DOWN-SECTION. FN/MD/CS 20/40/40 COARSENING DOWN SECTION. 5-6.0 - MOIST, TAN FN/MD/CS GR SAND W/ GRAVEL (AS ABOVE) FINES INCREASING F/M/C = 30/40/30 OVA = 0.0ppm	1151 SS2 R=1.3	5 6 6 10	DRILLING NOTES
6					1/ DRIVE SPLIT SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPLIT SP 4-6' 4/ AUGER TO 9' 5/ DRIVE SPLIT SP 9-11' SAMPLE ~~BX010~~ BX370101 6/ AUGER TO 14' 8/ H_2O @ 14' 9/ DRIVE SPL SP 14-16 10/ REMOVE HSAs 11/ GROUT BH 14-SURFACE
9		TAN, MOIST MD/CS GR SAND W/GRAVEL. FN/MD/CS = 10/40/50 GRAVEL SUBROUNDED, PHYLLITE, QTZITE, GRANODIORITES, SOME WEATHERING, 10-11' - FN/MD GRAINED GRAVEL. MOIST FN/MD = 40/60 NO GRAVEL MINOR CS GRAINS	1201 R=1.3'	4 5 5 6	
11					
14		H_2O @ 14' 14-15 WET FN GR SAND W/MINOR SILT (<10%) FE BANDING 15-15.5 MD/CS GR GRAVELLY SAND GRAVEL WEATHERED, QTZITE PHYLLITE, GRANODIORITE ~~15.5~~ 15.5-16 FN GR SILTY SAND W/ SILTY CLAY BANDING, TIGHT PLASTIC	1210 R=1.3	8 11 14 19	
16					SAMPLES 9-11' - BX370101* 14-16' BX370102 (W/DUP) * THE DUPLICATE SAMPLE FOR THIS INTERVAL WAS CHANGED TO INTERVAL FROM 14-16

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BORING LOG GENERAL DATA

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Project: SUDBURY ANNEX | Boring: E3 P37-B02 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (8/6/93; START/FINISH - 1420/1515) GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-.2' BROWN SANDY SILT DRY LOOSE .2-1 CS GR SND W/GRAVEL LOOSE 1-2' MOIST, TAN, MD/CS SAND W/GRAVEL GRAVEL SUBROUNDED GRANODIORITE QTZ PHYLLITES MD/CS = 50/50	SS1 1420 R=	3 4 3 4	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL 2/ DEPTH & R IN FEET 3/ 4¼ HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		MOIST, TAN, MED/CS GRAINED SAND W/GRAVEL, LOOSE MD/CS/FN 70/20/10. GRAVEL <10%, GRANODIORITE, QTZ, QTZITE, PHYLLITE	SS2 1428 R=1.5	4 4 4 6	
6					DRILLING NOTES 1/ DRIVE SPL SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPL SP 4-6' 4/ AUGER TO 9' 5/ DRIVE SPLIT SP 9-11' 6/ AUGER TO 14' 7/ DRIVE SPL SP 14-16' 8/ H_2O @ 14' 9/ REMOVE HSAs 10/ GROUT 14 - 0' SURF
9		9-10' TAN MED/CS/GRAINED SAND MOIST, MINOR GRAVEL <5% 10-11' 100% FN GRAINED SILTY SAND FE BANDS (STREAKS)	SS3 1438 R=1.6	4 4 5 6	
11					
14	▽	H_2O @ 14.0' WET TAN 100% FN GRAINED HOMOGENEOUS SILTY SAND AS ABOVE, FE BANDING	SS4 1459 R=1.7	5 5 6 7	
16		TD - 14'			SAMPLES 9-11' - BX370201 14'-16 BX370202 MSD - 14-16'

Project: SUDBURY ANNEX

Boring: E3-P37-B03

Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/16/97 Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
0		0-0.4 Silty Sand; dark brn; low moisture; 60% F, 40% M; high organics 0.4-1.2' Silty Sand; med. brn → lt. brn; low moisture; 20% F, 60% M, 20% C; 0-15% gravels up to ¼" diam; iron staining; minor organics	SS1 OVA	2, 4, 6, 7 1.2'R
2		Silty Sand; med brn; moist; 40% F, 60% M; no gravels; few organics		
4		4.0-4.5 Silty Sand; med brn; moist; 20% F 40% M, 40% C; 10-15% gravels up to 1/8" diam 4.5-5.2 Silty Sand; lt. brn; moist; 40% F, 60% M some coarser layers; iron staining; few small gravels	SS2 OVA =	2, 7, 7, 6 1.2'R
6		↓		
9		9.0 Silty Sand; med brn; high moisture; 20% F; 60% M; 20% C w/ increasing fines w/depth; iron staining throughout. Few small gravels	SS3 OVA =	7, 10, 10, 12 1.7'R
11		↓		
14		14-14.2' Silty Sand; grey brn; wet 20% F; 40% M; 40% C; iron stained minor clay lenses present 14.2-14.4 Clayey Sand; gray brn; wet 80% F; 20% M; dense; low plasticity	SS4 OVA =	6, 9, 7, 9 1.4'R
16		TD = 14'		

Drilling Data

Time Start: 0821
Time Stop: 0940

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.

2) DEPTH AND RECOVERY IN FEET.

3) 4 1/4 INCH DIA. HOLLOW STEM AUGERS

4) 2 INCH X 2 FEET SPLIT SPOONS

DRILLING NOTES

1) DRIVE SPL SP 0-2
2) AUGER TO 4'
3) DRIVE SPL SP 4-6
4) AUGER TO 9'
5) DRIVE SPL SP 9-11'
6) AUGER TO 14' (TD)
7) DRIVE SPLIT SP 14-16 H_2O ≅ 12'
8) REMOVE HSAs
9) GROUT 14' TO SURF

SAMPLES

4-6 BX370301
14-16 BX370302

BORING LOG GENERAL DATA
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BORING LOG GENERAL DATA

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Project: Sudbury Annex

Boring: E3-P38-B01

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8/10/94

START/FINISH - 0954/1030

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
0		0-0.1' Silty Sand; drk brn; low moisture 30% F, 40% M, 30% C; organics and some small gravels present 0.1-0.7' Silty Sand; lt brn → med brn; low moisture; 30% F, 40% M; 30% C; 10-20% gravels up to ½" diam	SS1 OVA = 0ppm	2, 3, 3, 3 0.7'R	OVA = 0.5ppm downhole = 0ppm w/meth. filter
2		Sand as above - except gravels increasing in size to 1½" diam			
4		4.0-4.8 Silty Sand; red brn; low moisture 40% F 60% M; 5-15% gravels up to ½" diam; 4.8-5.3 Silty Sand; lt brn; low moisture 20% F 40% M 40% C; 5-15% gravels up to ½" diam. Some stained gravels probably due to pyrite diagenesis	SS2 OVA = 0ppm	2, 4 5, 6 1.3'R	OVA = 10ppm down hole = 5ppm w/meth. filter
6					
6.5					
9		9.0-9.8 - Silty Sand, wet, gray brn to drk brn; 40% M, 60% C; few small gravels 9.8-10.2 - Silty Sand, med brn, wet 30% F 40% M 30% C; few gravels some pyrite	SS3 OVA = 0ppm	2, 4, 5, 9 1.2'R	
11		TD 9'			

DRILLING NOTES

1) DRIVE SPL SP 0-2
2) AUGER TO 4'
3) DRIVE SPL SP 4-6
4) AUGER TO 9' TD
5) DRIVE SPL SP 9-11'
H_2O @ 6.5'

SAMPLES

4-6 BX380101
9-11 BX380102

usagridal pm4

Power Auger

Project: Sudbury - ~~Test Pits~~ - 9/24/93			Boring: E3-P38-~~B01~~ BØ2		Page: 1 of 1
Depth/ Elevation (Ft.)	**USCS Symbol/ Core Sketch**	**Soil/Rock Description**	**Sample Number & Depth**	**Blow Count & Recovery**	**Drilling Data** 1130 → 1145
0		Silty Sand; med. brn; 60%F, 40%M; 20-25% gravel up to 1" diam			
1		Silty Sand; med. brn → gray brn; 60%M, 40%C; 20-25% gravel up to 1" diam			
2			E3P38BØ11		OVA = Oppm
3					
4	▽				
5		TD = 5'	E3P38BØ12		OVA = Oppm

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Power Auger

BØ3

Project: Sudbury - ~~Test~~ Pits - 9/24/93			Boring: E3-P38-~~Ø2~~		Page: 1 of 1
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1240 → 1300
0		Silty Sand; med brn/red brn; 40%F, 60%M; iron stained throughout; few small gravels up to 1/4" diam; high silt content.			
1					
2			E3P38P021		OVA = 0ppm
3		Silty Sand; lt. brn; 60%M, 40%C; 20-25% gravels up to 1/2" diam; increased moisture near bottom low silt content.			
4					
5		TD = 5'	E3P38P022		OVA = 0ppm

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BC NG LOG GENERAL DATA
Borehole Number: E3-P48-BØ1
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Date Sent:
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Project: Sudbury Annex				Boring: E3-P48-BØ1	Page: 1 of 1
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/10/93 Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data Time Start: 1601 Time Stop: 1631
		GROUND SURFACE			
0–2		0-0.5' - Silty Sand; drk brn; low moisture; 40% F, 60% M; high organics. 0.5-1.7' - Silty Sand; med brn → red brn; low moisture; some gravels up to ¼"; iron stained layers; minor organics	SS1 OVA = 0ppm	1, 3, 2, 2 1.7'R	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL 2/ DEPTH & R IN FEET 3/ 4¼" HSAs 4/ 2" X 2' SPLIT SPOONS
2–4		Silty Sand; lt. brn; low moisture; 40% F, 60% M; few gravels; clean; very low silt content			
4–6		Silty Sand; lt. brn; some moisture; 20% F, 60% M, 20% C; some coarser layers; iron stained layers; clean; very low silt content	SS2 OVA = 0ppm	2, 6, 4, 6 1.3'R	
6–9	▽ (8)	6-7.5 Sand as above except red brown 7.5-9 Silty Sand; wet at 8', 40% M, 60% C; 10-15% gravels up to ½" diam; low silt content			
9–11		Silty Sand; grey brn; wet; 60% M, 40% C; 10-15% gravels up to ¼" diam	SS3 OVA = 90ppm	2, 3, 5, 3 1.2'R	OVA = 90 ppm on spoon = 0 ppm w/ methane filter
		TD = 9'			DRILLING NOTES: 1) DRIVE SPL SP 0-2 2) AUGER TO 4' 3) DRIVE SPL SP 4-6 4) AUGER TO 9' (TD) 5) DRIVE SPL SP 9-11' H_2O @ ~8'
					SAMPLES 4-6 BX480101 9-11 BX480102

08/11/93

Project: SUDBURY ANNEX

Boring: E3-P48-B02

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8/11/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description START/FINISH - 0840/0930 GROUND SURFACE ORGANICS	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0.0-0.8 Tan to Brown fine to med silty sand with some medium pebbles (~60% F). 0.8-0.9 Charcoal and burnt organics. 0.9-1.4 Dark brown to Brown fine to medium silty sand, some organic matter (fine roots). 1.4-2.0 Tan to orange tan fine to medium silty sand (~40% F).	SS-1	2 / 2 / 4 / 4 / R=1.5'	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2		2.0-4.0 SAA with ~10% fine to medium pebbles.			2) DEPTH AND RECOVERY IN FEET
4		4.0-6.0 Tan to orange tan med to cs clean sand with ~20% fine to med. pebbles. some iron staining.		1 / 7 / 13 / 13 / R=1.3'	3) 4.25 INCH DIA. HOLLOW STEM AUGERS 4) 2 INCH X 2 FEET SPLIT SPOONS
6		6.0-9.0 SAA with med to cs pebbles.			DRILLING NOTES
7.5	▽				1) DRIVE SPLIT SP 0-2
		TD BH			2) AUGER TD 4'
9		9.0-11.0 Gray-Brown coarse sand with (~20%) fine to med. pebbles.		2 / 5 / 5 / 4 / R=0.8'	3) DRIVE SPL SP 4-6' 4) AUGER TD 9' (TD) H_2O @ 7.5'
11					5) DRIVE SPLIT SP 9-11 6) REMOVE HSAs 7) GROUT 9'-SURF

SAMPLES

4-6 BX480201

9-11 BX480202

BORING LOG GENERAL DATA

Borehole Number: E3-P48-B02

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usagndal pn14

Project: SUDBURY ANNEX

Boring: EZ-P48-B03

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4/16/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
0–2		0-0.5 silty sand; dk brn; low moisture; 60% F 40% M; high organics 0.5-1.3 silty sand; med brn - lt. brn; low moisture 40% F, 60% M; minor organics 1.3-1.7 silty sand; lt. brn; low moisture; 20% F 40% M, 40% C; 10-15% gravels up to 1/4" dia	SS1 OVA	4, 5 6, 7 1.7'R
2–4		Sand as above except decreased gravels and increased fines		
4–6		4-4.2 Sand as above 4.2-5.3 silty sand; med. brn; increased moisture; 10% F; 40% M; 50% C; 10-15% gravels up to 1/4" dia; few large gravels up to 1" dia at 5.2'	SS2 OVA	4, 12 13, 18 1.3'R
6–9	8 H_2O	Sand as above except decreased gravels		
9–11		silty Sand; med brn → gry brn,	SS3 OVA	6, 10, 10, 5 1.7'R

TD = 9'

Drilling Data

Time Start: 1038

Time Stop: 1125

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.

2) DEPTH AND RECOVERY IN FEET.

3) 4 1/4 INCH DIA. HOLLOW STEM AUGERS

4) 2 INCH X 2 FEET SPLIT SPOONS

DRILLING NOTES

1) DRIVE SPL SP 0-2'
2) AUGER TD 4'
3) DRIVE SPL SP 4'-6'
4) AUGER TD 9'
5) DRIVE SPL SP 9-11'
H_2O @ ≈ 8.0'
6) REMOVE HSAs
7) GROUT 9' > SURF

SAMPLES

4-6 BX480301

9-11 BX480302

BORING LOG GENERAL DATA

Borehole Number:

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WATERSHED 5

Boreholes:

E3-P31-B01 (power auger)
E3-P31-B02 (power auger)
E3-P31-B03 (power auger)

Power Auger

Project: Sudbury - ~~Test Pits~~ -9/24/93 | Boring: E3-P31-~~PØ1~~ BØ1 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
					0815 → 0900
0		Silty Sand; drk brn → blk; 60%F, 40%M; high organics; few gravels up to 1" diam.			
		Silty Sand; med. brn → lt. brn; 30%F, 40%M, 30%C; 10-15% gravels up to 1/4" diam; iron stained throughout			
1					
2		- - - - - - - - - - - - →	E3P31PØ1 (2')		OVA = 0ppm
3		Silty Sand as above except lt. brn, little iron staining and few gravels			
4					
5		TD = 5'	E3P31PØ2		OVA = 0ppm

BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

usagndat.pm4

Power Auger

Project: Sudbury - Test ~~Pits~~ = 9/24/93	Boring: E3-P31-~~P02~~ B02	Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 0920 → 0930
0		silty sand; drk brn → blk; 60%F, 40%M high organics; many roots; few gravels.			
		silty sand; red brn; 40% F 60%M; iron stained throughout; 5-10% gravels up to 1/8" diam			
1					
2			E3P31P021		OVA = 0ppm
3					
4					
5			E3P31P022		OVA = 0ppm
		TD = 5'			

usagndat.pm4

BORING LOG GENERAL DATA
Borehole Number: ____ Page: 3 of ____ Signature: ____ Xerox: ____ Sent to USATHAMA: ____ Date Sent: ____

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Power Auger

Project: Sudbury - ~~Test Pits~~ - 9/24/93			Boring: E3-P31-~~P03~~ B03		Page: 1 of 1
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 0940 → 0955
0		Silty Sand; blk; 70%F, 30%M; very few gravels; high organics & silt content; very moist			
1		Clayey Sand; med. brn. → drk brn; 60%F, 40%M; Few gravels up to 1/8" diam; 10-15% clay			
2	▽		→ E3P31B031		
3		TD = 3'			

BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

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usagndat.pm4

WATERSHED 6

Boreholes:

E3-P01-B01
E3-P01-B02
E3-P01-B03
E3-P02-B01
E3-P02-B02
E3-P02-B03
E3-P02-B04

Project: SUDBURY ANNEX **Boring:** E3-P01-B01 **Page:** 1 of 1

8/6/93

Drilling Data

Time Start 1600
Time Stop 1820

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
0		GROUND SURFACE – Cobbles up to 4" diam		
0–2		Silty Sand, red brown, low moisture 40%M, 60%C; 15-20% subangular gravels up to 3/4" diam; low organics	SS1 OVA= 0ppm	6, 6, 10, 14 1.0'R
2–4		Sand as above except drk brn		
4–6		Silty Sand - med brn; moist; 30% M, 70% C large piece of granite in spoon prevented recovery	SS2 OVA= 0ppm	10, 46 refusal 0.1'R
6–9		Sand as above		
9–11		Silty Sand - med. brn.; moist; 10%F, 40%M, 50%C; 10-20% gravel up to 1/4" diam large piece of granite prevented more recovery	SS3 OVA= 0ppm	36, 18, 19, 26 1.0'R
11–14		Sand as above Cobbles encountered up to 4" diam		
14–16 (water ▽ 15)		14.0-14.5 Sandy Clay - med. brn; 5-15% gravels up to 1/4" diam; very dense; low plasticity; moisture increases toward bottom 14.5-15.5 Silty Clay - gray brn; few gravels; very dense; low → moderate plasticity	SS4 OVA= 0ppm	8, 4, 15, 19 1.5'R
16–19				
19–21		Clay as above w/ large piece of granite cobble at 19.3'	SS4 OVA= 0ppm	14, 14, 32, 4.1 0.8'R

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2) DEPTH AND RECOVERY IN FEET.
3) 4 1/4 INCH DIA. HOLLOW STEM AUGERS
4) 2 INCH X 2 FEET SPLIT SPOONS.
→ 3" Split Spoon

DRILLING NOTES

1) DR SPL SP 0-2
2) AUGER TO 4'
3) DRIVE SPL SP 4-6
4) AUGER TO 9'
5) DRIVE SPL SP 9-11
6) AUGER TO 14'
7) DRIVE SPL SP 14-16
8) HLDR 15.0'
9) AUGER TO 19'
10) DRIVE SPL SP 19-21

OVA = 0ppm down hole

water at ≈ 15'

TD = 19'

11) GROUT BH 19' TO SURF.

SAMPLES

9-11 BX010101
14-16 BX010102

BORING LOG GENERAL DATA
Borehole Number: ______ Page: 2 of ____
Signature: ______ Sent to USATHAMA: ______ Date Sent: ______

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Project: SUDBURY ANNEX

Boring: E3-701-302

8/13/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE ORGANICS			START/FINISH 1-0850/0915
		0.0-0.5 Dark Brown very fine to fine silty sand (~80% F) with organics.		1	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
		0.5-1.0 Orange-tan fine silty sand, no organics (~60% F)	SS-1	6	
		1.0-2.0 Light tan to yellow fine silty sand with mica flakes and fine pebbles.		10	
				21	
				R=1.0	
2		2.0-4.0 Light orange-tan fine to med. silty sand with ~60% Fines and ~20% fine to cs pebbles.			2) DEPTH AND RECOVERY IN FEET.
4		4.0-5.0 Tan-gray fine to med silty sand with ~15% clay.		20	3) 4.25 INCH DIA. HOLLOW STEM AUGERS
		— AUGER REFUSAL AT 5' BGS		60	
		SEE NEXT SHEET.		REFUSAL-BENT SPOON	4) 2 INCH X 2 FEET SPLIT SPOONS
6				R=0.5	

1) DRIVE SPL SP 0-2
2) AUGER TO 4'
3) DRIVE SPL SP 4-5'
REFUSAL @ 5'
4) MOVE 3' FROM THIS POINT

BORING LOG GENERAL DATA

Borehole Number: E3-701-302

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Signature:

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Sent to USATHAMA:

Date Sent:

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Project: SUDBURY ANNEX

Boring: E3-P02-B02

Page: 2 of 2

8/13/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			START / FINISH - 0940 - 1040
		0.0 - 4.0 see first page			1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
4		4.0-9.0 - Tan-gray fine to med silty sand with ~15-20% clay (cohesive) and ~20% fine to medium pebbles. Drill bit encountered several large boulders (24"+).			2) DEPTH AND RECOVERY IN FEET. 3) 4¼-INCH DIA. HOLLOW STEM AUGERS
9		9.0-11.0 SAA and broken fragments of pebbles and boulders.	SS-3	22 / 36 / 28 / 30 / R=0.5	4) 2 INCH X 2 FEET SPLIT SPOONS
11		11.0 14.0 SAA			
	▽	TD Bit			
14		14.0-16.0 Tan-gray to tan green very fine to fine silty sand with ~30% clay. very stiff and cohesive	SS-4	4 / 30 / 80 / REFUSAL / R=0.6	See Photo 8,9 1045 hours.
16					1) AUGER TO 9' 2) DRIVE SPL SP 9-11 3) AUGER TO 14' 4) DRIVE SPL SP 14-16' 5) TD = 14' H_2O @ 14' 6) GROUT BH 14' - SURF

SAMPLES

0-2' BX010201

14-16 BX010202

BORING LOG GENERAL DATA
Borehole Number:
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Signature:
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Sent to USATHAMA:
Date Sent:

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BORING LOG GENERAL DATA
Borehole Number: E3-701-303
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Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX | Boring: E3-701-303 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	8/13/93 Drilling Data START/FINISH-1100/1240
		GROUND SURFACE ORGANICS			
		0.0-0.5 Dark Brown very fine to fine silty sand, organics (loam) (~75% F) 0.5-2.0 Orange-Tan fine to medium silty sand with fine to med pebbles (~40% F)	SS-1	2 6 7 9 R=0.6	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL. 2) DEPTH AND RECOVERY IN FEET.
2		2.0-4.0 SAA, several large boulders (24"+) encountered by drill bit.			3) 4¼-INCH DIA. HOLLOW STEM AUGERS
4		4.0-6.0 SAA ~30% F.	SS-2	3 3 11 12 R=0.6	4) 2 INCH X 2 FEET SPLIT SPOONS
6		6.0-9.0 Tan-gray fine to med silty sand with 15-20% clay and fine to med. pebbles. TD Bit			DRILLING NOTES 1) DR SPL SP - 0-2' 2) AUGER TO 4' 3) DRIVE SPLIT SP 4-6 4) AUGER TO 9'
9	▽	9.0-11.0 SAA - with mica flakes		8 30 20 28 R=1.3	5) DRIVE SPL SP 9-11 6) H_2O @ 10' 7) TD = 9' 8) GROUT 9' TO SURF
11					
					SAMPLES 4-6'-BX010301 9-11-BX010302

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08/11/93

Project: SUDBURY ANNEX | Boring: E3-PC2-B01 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description — 8/11/93 — START/FINISH - 1140/1250 — GROUND SURFACE ORGANICS	Sample Number & Depth	Blow Count & Recovery	Drilling Data
0		0.0-2.0 Medium to Dark Brown fine to med silty sand (~40% F) with fine to med. pebbles	SS-1	4 / 6 / 13 / 10 / R=0.5	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2		2.0-4.0 SAA. Auger encountered several large rocks (estimated at 18-24"), but none in cuttings.			2) DEPTH AND RECOVERY IN FEET
4		4.0-5.0 SAA, fewer pebbles, fines with depth into: 5.0-6.0 Gray fine silty sand (~80% Fines) with 1/2 inch iron-stained layers in first 6 inches.	SS-2	3 / 6 / 9 / 7 / R=1.3	3) 4.25 INCH DIA. HOLLOW STEM AUGERS
6		6.0-9.0 Tan to Gray-tan fine silty sand (~80% F). Damp.			4) 2 INCH x 2 FEET SPLIT SPOONS
9		9.0-11.0 SAA. Damp.	SS-3	2 / 6 / 5 / 5 / R: 1.3	DRILLING NOTES: 1) DRIVE SPL SP 0-2' 2) AUGER TO 4' 3) DRIVE SPL SP 4-6' 4) AUGER TO 9' 5) DRIVE SPL SP 9-11' 6) AUGER TO 14 7) DRIVE SPL SP 14-16 H_2O @ 13'
11		11.0-14.0 SAA, fining with depth.			
13	▽				
14		TD BH — 14.0-15.5 SAA with ~90% F. wet. 15.5-16.0 Gray very fine silty sand with ~15% clay.		3 / 4 / 6 / 6 / R=1.5	
16					SAMPLES: 4'-6' - BX020101; 14'-16' BX020102

BORING LOG GENERAL DATA
Borehole Number: E3-PC2-B01
Page: 2 of ___ Signature: ___
Sent to USATHAMA: ___ Date Sent: ___
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BORING LOG GENERAL DATA
Borehole Number: E3-PC2-B02
Page: 2 of 1
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX | Boring: E3-PC2-B02 | Page: 1 of 1

8/11/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE ORGANICS			START/FINISH - 1257/1345
		0.0 - 0.5 Brown to Dark Brown fine to med silty sand w/ 10% cs grains and mica flakes and med. pebbles.	SS-1	3	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
		0.5-2.0 Brown to Orange-Brown fine silty ~~si~~ sand (~60% F).		6	
				7	
				3	
2				R=1.3	
		2.0-4.0 Tan to Gray fine to med clean sand.			2) DEPTH AND RECOVERY IN FEET
4		4.0-6.0 Tan to Gray med to cs clean sand		1	
				3	3) 4.25 INCH DIA. HOLLOW STEM AUGERS
				5	
				6	
6				R=1.0	
		6.0-9.0 SAA			4) 2 INCH x 2 FEET SPLIT SPOONS
9		9.0-11.0 SAA damp		2	DRILLING NOTES
				4	1) DRIVE SPL SP 0-2'
				3	2) AUGER TO 4'
				4	
11				R=1.5	3) DRIVE SPL SP 4-6'
		11.0 - 14.0 Tan to gray fine to med clean sand wet. fines with depth. wet.			4) AUGER TO 9'
12.5	▽				5) DRIVE SPL SP 9'-11'
14					6) AUGER TO 14'
		14.0- ~~16.0~~ 15.5 Tan to gray fine silty sand (~80% F).		3	7) DRIVE SPL SP 14'-16' H_2O @ ≈12.5'
		15.5 16.0 Gray to tan very fine silty sand with ~15% Clay.		4	
				3	8) GROUT BH 14'→SURF
				7	
16				R:1.5	
					SAMPLES
					4-6' BX020201
					14-16' BX020202

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BORING LOG GENERAL DATA
Borehole Number: E3-PC2-BC3
Page: 2 of 2 (handwritten "2" over printed "1")
Signature:
Sent to USATHAMA:
Date Sent:
Xerox:

Project: SUDBURY ANNEX

Boring: E3-PC2-BC3

Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE ORGANICS			START/FINISH - 1358/1450
		0.0-0.5 Dark Gray to brown fine to med. silty sand (~60% F) 0.5-1.0 Light tan med to cs clean sand. Fine to med pebbles throughout 0-1.0. 1.0-2.0 Dark brown to brown very fine to fine silty sand, some organics. (LOAM)	SS-1	2, 6, 4, 4, R= 1.3	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2		2.0-4.0 SAA with medium to cs pebbles and some cobbles.			2) DEPTH AND RECOVERY IN FEET
4		4.0-6.0 Tan to gray fine to med. clean sand, some iron staining on grains.	SS-2	2, 6, 5, 4, R: 1.0	3) 4.25 INCH DIA. HOLLOW STEM AUGERS 4) 2 INCH x 2 FEET SPLIT SPOONS
6		6.0-9.0 SAA, fines with depth.			DRILLING NOTES
9		9.0-11.0 SAA, but fine grained.	SS-3	3, 6, 4, 6, R=	1) DRIVE SPL SP 0-2 2) AUGER TO 4' 3) DRIVE SPL SP 4'-6' 4) AUGER TO 9' 5) DRIVE SPL SP 9'-11'
11		11.0-14.0 Tan to gray fine silty sand (~80% F).			6) AUGER TO 14' 7) DRIVE SPLIT SP 14'-16'
13	▽				H_2O @ ≈13'
14		TD BH			TD=14'
		14.0-15.5 SAA with some iron staining 15.5-16.0 Gray very fine silty sand with 15% Clay. Note ½" wide band of sand from above.	SS-4	8, 18, 18, 17, R=1.5	8) GROUT 14'-SURF
16					

SAMPLES

4-6'- BX020301

14-16'- BX020302

BORING LOG GENERAL DATA
Borehole Number: E3-PØ2-BØ4
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Signature:
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Xerox:
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Project: SUDBURY ANNEX

Boring: E3-P2-BØ4

Page: 1 of 1

8/12/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
0		0-0.5' silty sand; dark brn; low moisture 40% F, 60% M; high organics; 10-20% gravel up to 1" diam 0.5-1.0' Sand as above except no gravel 1.0-1.5' silty sand; red brn; low moisture 40% F, 60% M; minor organics	SS1 OVA= 0 ppm	3, 6, 11, 6 1.5' R
2		↓		
4		Silty Sand; lt. brn; low moisture; 20% F, 40% M, 40% C, slight increase in fines w/ depth some iron staining in top 2"	SS2 OVA= 0 ppm	3, 9, 9, 6 1.6' R
6		Sand as above w/ increased fines and minor clay present		
9	9-10.5'	Silty Sand; lt brn → grey brn; moist → wet at 10.5'; 20% F, 60% M, 20% C 10.5-10.6' Silty Sand; Med brn; wet; 40% M, 60% C 10.6-10.8' Silty Sand; lt. brn → red brn; wet; 60% F, 40% C, minor clay present	SS3 OVA= 0 ppm	2, 5, 5, 6 1.8' R
10.5 ∆				
11		↓		
14		Clayey Sand; red brn; wet; 80% F, 20% M 20-50% clay; some iron staining	SS4 OVA= 0 ppm	4, 6, 6, 11 1.6' R
16		Sand as above		
19		TD = 19'		

Drilling Data

Time Start: ~~0856~~ 0756
Time Stop: 0840

1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.

2) DEPTH AND RECOVERY IN FEET.

3) 4 1/4 INCH DIA. HOLLOW STEM AUGERS

4) 2 INCH X 2 FEET SPLIT SPOONS

DRILLING NOTES

1) DRIVE SPLIT SP 0-2'
2) AUGER TO 4'
3) DRIVE SPLIT SP 4-6
4) AUGER TO 9'
5) DRIVE SPL SP 9'-11'
6) H2O @ 10.5'
7) AUGER TO 14'
8) DRIVE SPL SP 14-16'
9) AUGER TO 19' (TD)
10) GROUT 19' → SURF

SAMPLES
4-6 - BX020401
9-11 - BX020402

APPENDIX B

WELL CONSTRUCTION LOGS

APPENDIX B

Appendix B contains field well construction schematics and field bore logs for all monitoring wells installed by Ecology and Environment, Inc. (E & E) at the Sudbury Annex. Please refer to Section 5.1.7 of Volume I for a description of well installation procedures. The logs are organized by watershed. Please note that no wells were installed in Watershed 1A.

WATERSHED 1B

GROUNDWATER MONITORING WELLS

E3-A2-M01
E3-P11-M01
E3-P13-M01
E3-P13-M02
E3-P13-M03
E3-P13-M04
E3-P23-M01
E3-P26-M01
E3-P26-M02
E3-P26-M03

WELL CONSTRUCTION LOG

Site ID: A2 ws

Well Number: E3-A2-M01 ws

Job Number:

Today's Date: 8/4/93

Well Start/Completion Dates: 8/4/93, 8/4/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC

Schedule: 40

Type: Continuous Slot HORIZONTAL

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10'

Screened Interval:

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL

Open Area per Foot of Screen: in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length:

Diameter: (ID) 4.0 (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED

Composition

Depth(s)

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE

Use(s)

Protective Casing: Material HARDENED STEEL

Inner Diameter 6.0"

Page 1 of 3 Xerox: Sent to USATHAMA:

Signature: Date Sent:

WELL CONSTRUCTION LOG

Well Number:

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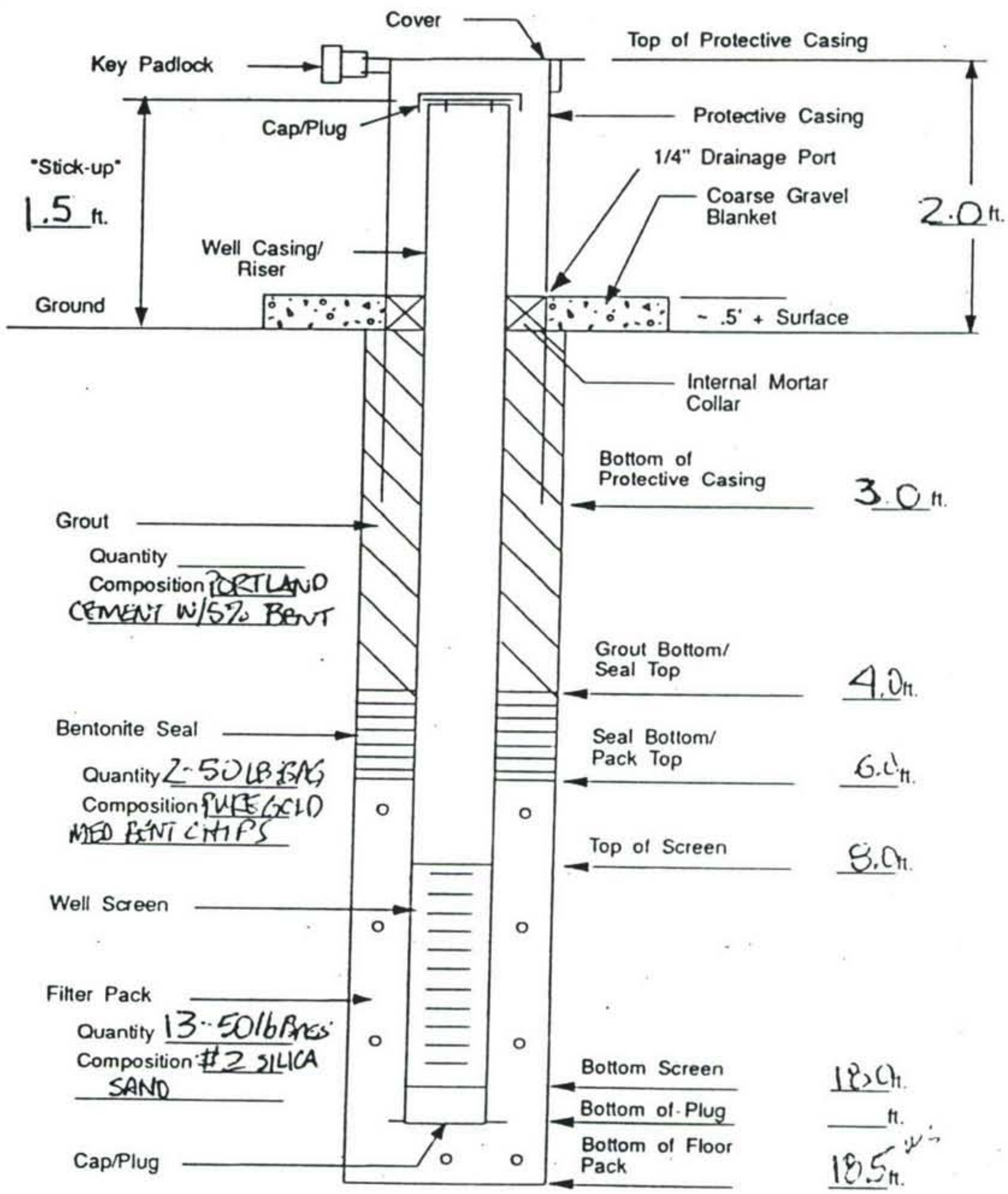
Well Construction Log: WG
Site ID Number: A2
Well Number: E3-A2-M01
Today's Date: 8/4/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-A2-M01
Page 2 of 3
Signature: Xerox: Walter Gut
Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX | Boring: E3-A2-M01 | Page: 1 of 4

BORING LOG GENERAL DATA
Borehole Number: E3-A2-M01
Page: 2 of
Signature:
Xerox: Walter Ruel
Sent to USATHAMA:
Date Sent:

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/4/93 Soil/Rock Description START/FINISH - 1220/1400 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
2		SS1 - 0-6". TOPSOIL, PLANTS W ROOT ZONE. DK BROWN SILT W/MINOR SAND GRADING TO LIGHT BROWN FN GRAINED SAND HOMOGENEOUS DRY OVA = 0.0 ppm	1221 R=1.5	1 5 4 4	NOTES 1/ SPLIT SPOONS DRIVEN W/140LB HAMMER W/30" FREE FALL 2/ DEPTH & "R" IN FEET 3/ 8 1/4" HSAs 4/ 2" X 2' SPLIT SPOON
4		SS 2 - DRY LIGHT BROWN SAND, AS ABOVE 0.2', GRADING TO MED - CS GRAINED GRAVELLY SAND. MOIST. GRAVEL QTZ, QTZITE, PHYLLITES, FN/MED/CS 20/40/40. BECOMING MOIST AT BOTTOM OF SPOON	1233 R=1.2'	3 5 8 11	DRILLING NOTES 1/ DRIVE SPL SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPL SP 4-6 4/ AUGER TO 9' 5/ DRIVE SPL SP 9-11' 6/ H_2O @ 10.5' 7/ AUGER TO 14' 8/ DRIVE SPL SP 14-16 9/ AUGER TO 18' 10/ INSTALL MW
6					
9		SS3 MOIST CS GRAINED SAND W/ BECOMING GRAVELLY @ 10', WET @ 10.5' ~~GRAVEL TO~~ SAND W/GRAVEL, GREY POORLY SORTED, FN/MED/CS - 20/40/40 SAND/GRAVEL = 90/10. GRAVEL SUBROUNDED QTZ QTZITE PHYLLITE GRANODIORITE	1244 R=1.4	4 5 4 8	
10.5	▽				
11		H_2O @ 10.5'			
14		SS4 - ORANGE-TAN SAND W/GRAVEL WET POORLY SORTED, GRAVEL WEATHERED SUBROUNDED QTZ, PHYLLITE GRANODIORITE, SAND FN/M/CS 20/30/50 SND/GRAVEL 50/50. CONTACT @ 15.5 GREY-BR CLAY, HOMOGENEOUS, PLASTIC	1253 R=1.1	3 6 4 3	
16					SAMPLES 9-11' BX0201X1

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BORING LOG GENERAL DATA

4 WG

Project: SUDBURY ANNEX   Boring: E3-A2-MC1   Page: 3 of 4

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E   Signature: Walter Graf

Date Boring Started: 8/4/93   Completed: 8/4/93

Water Levels (from Ground Surface)   Drilling Rig: INGERSOLL-RAND-A-300

First Encountered: 10.5   Date: 8/4/93

While Drilling: 10.5   Date: 8/4/93

At Boring Completion: 10.5'   Date: 8/4/93

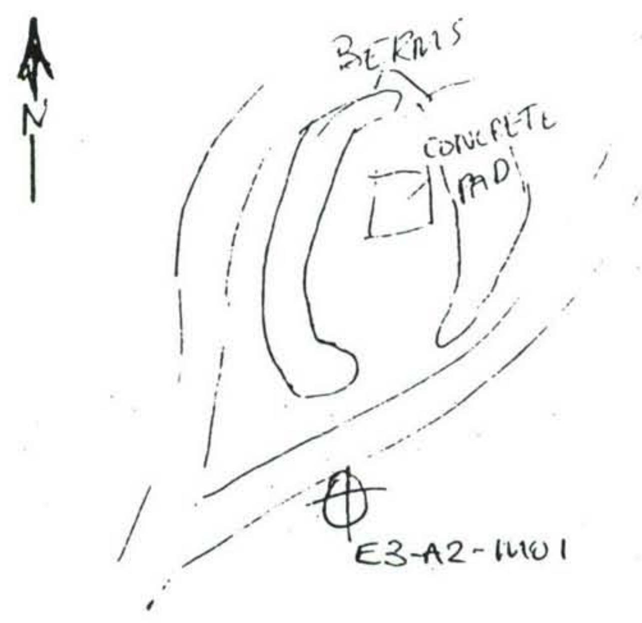
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/4	1220	1400	0	18					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: E3-A2-MC1 WS
Page: 1 of
Signature: Walter Graf
Xerox:
Sent to USATHAMA:
Date Sent:

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SUDBURY ANNEX

WELL CONSTRUCTION LOG

Page: 1 of ~~3~~ 4

Site ID: P11

Well Number: E3-P11-M01

Job Number: UC60666

Today's Date: 08/03/93

Well Start/Completion Dates: 08/03/93 / 08/03/93

Installation Difficulties: Bottom of screen caught on auger - pulling augers pulled the well, had to tremmy well back down.

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC.

Schedule: 40

Type: Continuous Slot HORIZONTAL SLOT, 1/4 INCH SPACING

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10 FEET

Screened Interval: 8.0' - 18.0'

Diameter: (ID) 4.0 INCHES (OD) ~~4.25~~ 4.50 INCHES

Thickness: ~~0.0200~~ 0.25"

Slot: Size (inches): 0.020 Configuration: 1/4" HORIZ. SLOT

Open Area per Foot of Screen: ~~0.96 inches~~ 151 INCHES^2

Casing

Manufacturer: BEDROCK ENTERPRISES INC.

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length: 10'

Diameter: (ID) 4.0" (OD) ~~4.25"~~ 4.50"

Thickness: 0.25"

Joint(s): Design THREADED

Composition

Depth(s)

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer N/A

Use(s)

Protective Casing: Material STEEL

Inner Diameter 6 INCH

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WELL CONSTRUCTION LOG

Well Number:

Page 1 of 3

Signature:

Xerox:

Sent to USATHAMA:

Date Sent:

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WELL CONSTRUCTION LOG
Well Number: ____
Page 2 of 3
Signature: ____ Xerox: ____
Sent to USATHAMA: ____
Date Sent: ____

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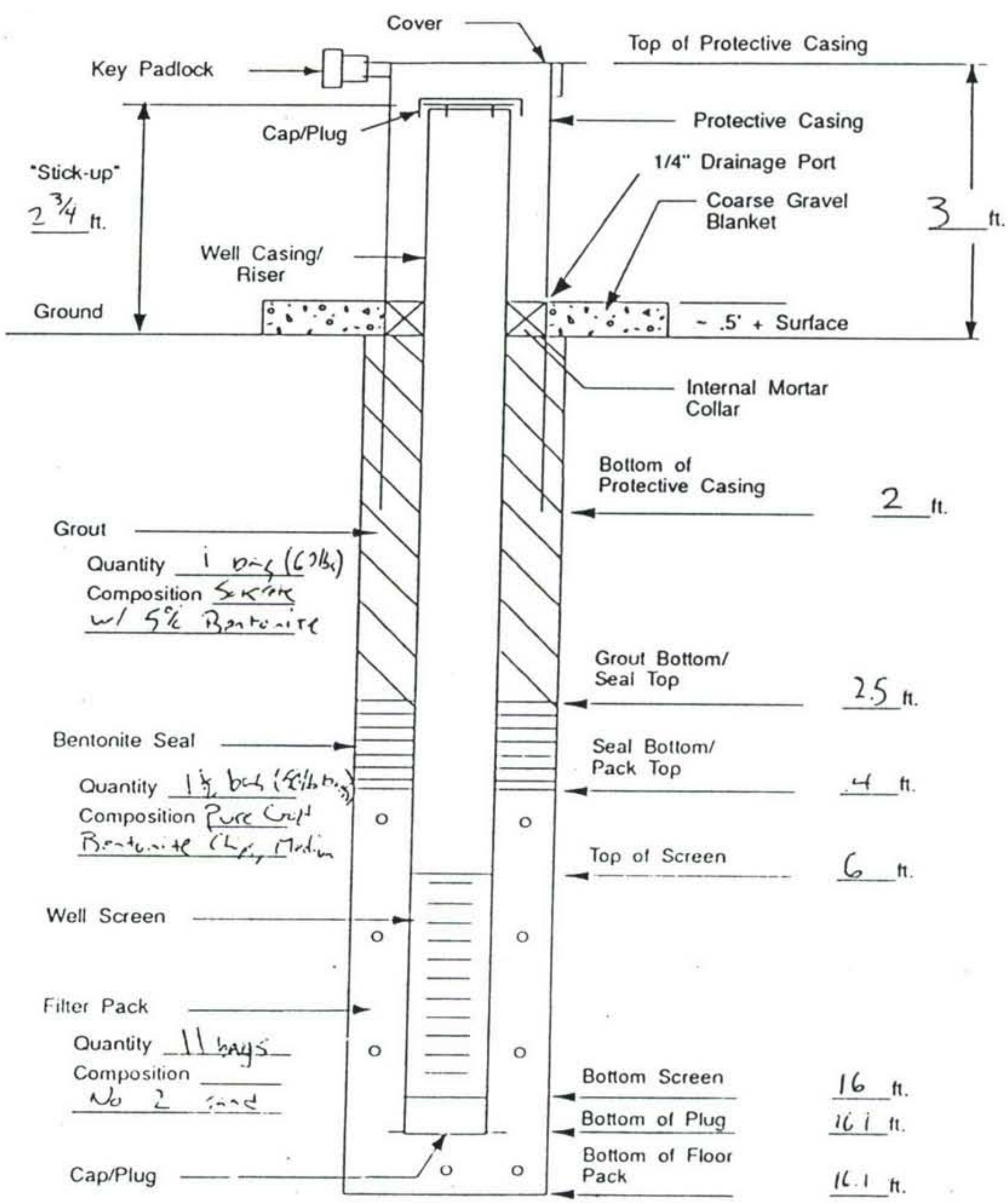
Well Construction Log: ____
Site ID Number: ~~P13~~ P11
Well Number: E3-P11-MO1
Today's Date: 08/03/93

WELL CONSTRUCTION



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Project: Sudbury Annex			Boring: E3-P11-M01		Page: 3 of 4
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data Time Start: 0845 Time Complete: 1000
0		GROUND SURFACE 1" Organic			
		0-0.4 - Silty Sand, medium brown, low moisture, 30% F, 60% M, 10% C 20-25% gravels up to 1" diam. some organics 0.4-0.8 - Silty sand; dark brown; low moisture, 40% F, 60% C; 15-20% gravel up to ½" diam; high organics	SS1 (0-2') OVA=0ppm	3, 5, 11, 10 R=0.8'	① 6¼" HSA ID ① 2" split spoons drive by 140 lb hammer w/ HSA 0-4'
2		Sand as above - decrease in gravels, decrease in organics medium brown.			
4		Sand as above - except 50% F, 50% M, decrease in organics increase in moisture at bottom of spoon.	SS2 (4-6') OVA=0ppm	7, 11, 10, 13 R=0.2'	Split Spoon pushing cobble. HSA 4-9'
6		Silty Sand - medium brown; 20% F 40% M, 40% C, 5-10% gravels 1/4" diam. High moisture wet at ≅ 8 ft			OVA = 2ppm down hole
9		9-9.6' Silty Sand - Grey Brown, High moisture → wet; 90% F, 10% M, 20-30% silt, minor clay; dense; moderate plasticity 9.6-10.2' Sand as above except 70% F 30% M	SS3 (9-11') OVA=0ppm	9, 10 10, 11 R=1.2'	HSA 9-14'
11		↓			
14		Sand as above - except 90% F, 10% M	SS4 OVA=0ppm	8, 10 12, 5 R=0.8'	HSA 14-19'
16		Sand as above w/ increased grain size to bottom		~~8, 10, 12, 5~~ ~~R=0.8'~~	
19		19' Bottom of Boring			

BORING LOG GENERAL DATA
Borehole Number:
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Signature:
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Date Sent:
Xerox:

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BORING LOG GENERAL DATA

Project: Sudbury Annex | Boring: E3-P11-MØ1 | Page: 4 of 4

Driller & Company: Dave Gagne / ESD

Geologist/Logger & Company: John Pasch/E+E | Signature:

Date Boring Started: 8/3/93 | Completed: 8/3/93

Water Levels (from Ground Surface) | Drilling Rig: Mobil

First Encountered: 8.0' | Date: 8/3/93

While Drilling: 8.0' | Date: 8/3/93

At Boring Completion: 8.0' | Date: 8/3/93

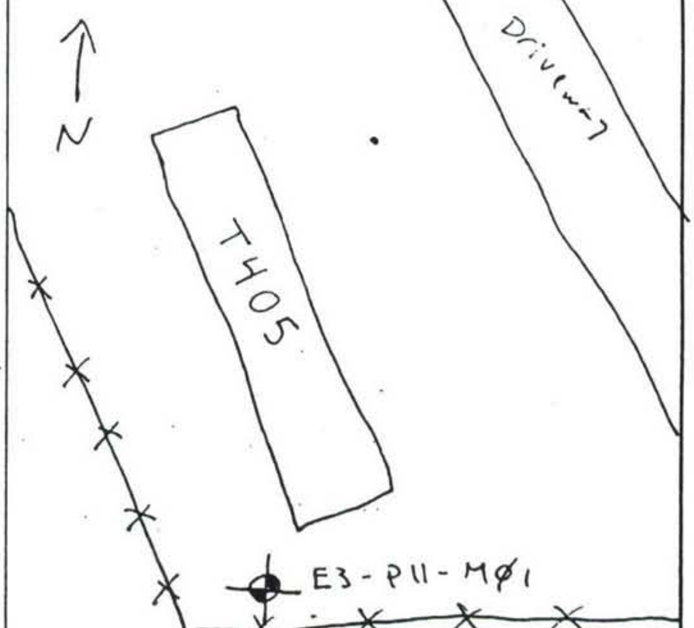
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/3	0845	1000	0'	19'					

Abbreviations:

Abbr.	Meaning
SS	Split Spoon
R	Recovery
F	Fine
M	Medium
C	Coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______ Page: 1 of ______
Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

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Page: 1 of ~~3~~ 5

WELL CONSTRUCTION LOG

Site ID:
Well Number: E3-P13-01
Job Number: UC6066
Today's Date: 8/3/93
Well Start/Completion Dates:
8/2/93 / 8/3/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: Bedrock Enterprises Inc.
Schedule: 40
Type: Continuous Slot Horizontal Slot 0.25" Spacing
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10 ft
Screened Interval: 9.0' - 19.0'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: 0.25"
Slot: Size (inches): 0.020 Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: Bedrock Enterprises Inc.
Schedule: 40
Material: Stainless Steel
PVC X
Other
Length: 10'
Diameter: (ID) 4.0" (OD) 4.50"
Thickness: 0.25"
Joint(s): Design Threaded
Composition PVC
Depth(s) 9.0'
Centralizer: Design N/A
Composition
Depth(s)
Solvent, Glues, Cleaners: Manufacturer N/A
Use(s)
Protective Casing: Material Steel
Inner Diameter 6"

WELL CONSTRUCTION LOG
Well Number:
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Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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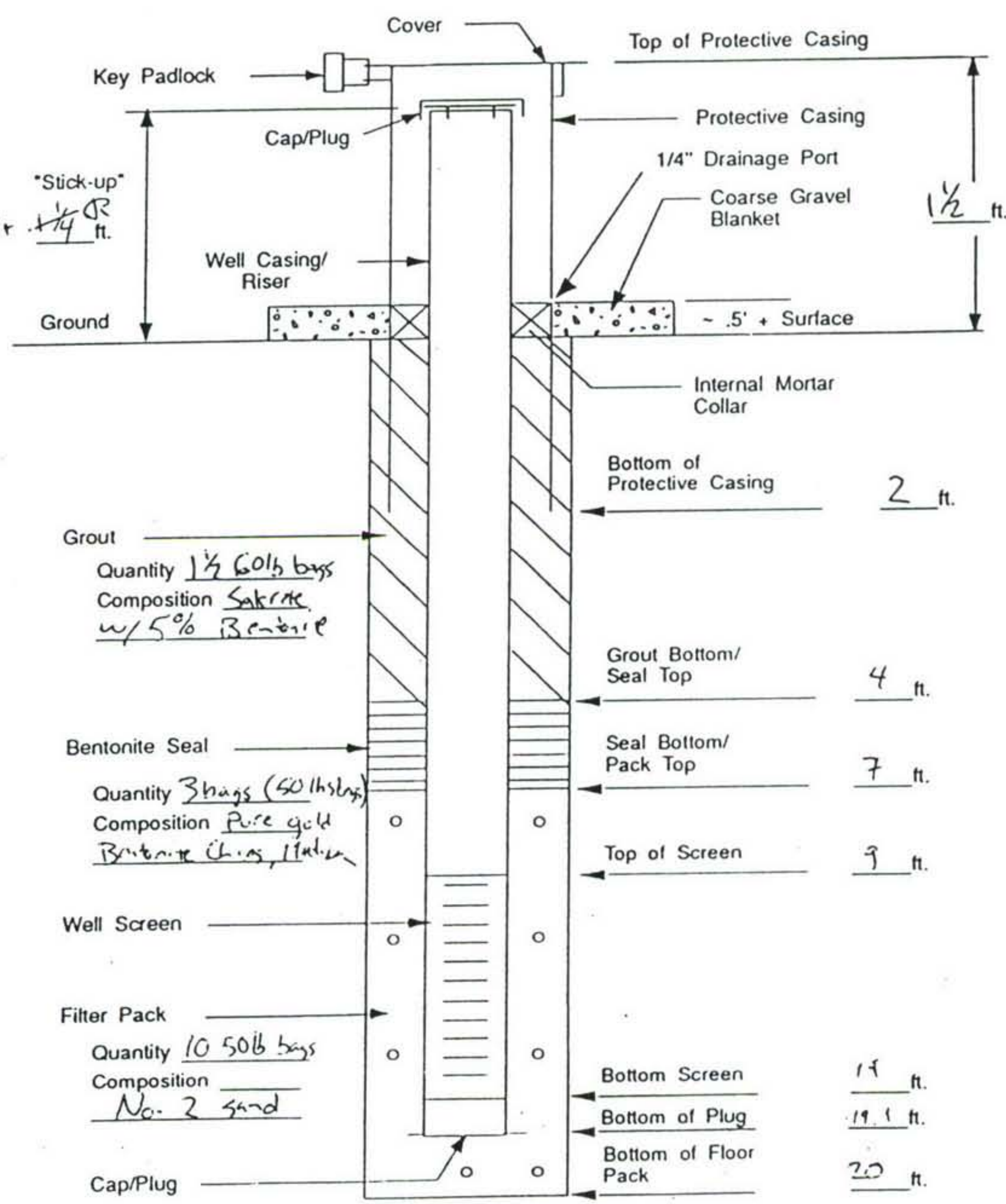
Well Construction Log: ______
Site ID Number: P13
Well Number: F3 - P13 - 01
Today's Date: 8/3/93

WELL CONSTRUCTION



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WELL CONSTRUCTION LOG
Well Number: ______
Page 2 of 3
Signature: (Xerox)
Sent to USATHAMA: ______
Date Sent: ______

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Project: SUDBURY ANNEX	Boring: E3-P13-M01	Page: ~~1~~ 3 of ~~2~~ 5

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description GROUND SURFACE ORGANICS	Sample Number & Depth	Blow Count & Recovery	8/2/93 Drilling Data START/FINISH - ~~0845/1000~~ 1627/1737 JR
		0.0-0.5 DARK BROWN SILTY SAND (75% FINES) 0.5-2.0 LIGHT BROWN SILTY SAND (95% FINES)	SS-1	4 8 8 7 R=1.5	Ø ppm OVA
2		2.0-4.0 LIGHT BROWN TO BROWN SILTY SAND WITH SOME FINE QUARTZ PEBBLES AND VERY COARSE SAND GRAINS			
4		4.0-6.0 BROWN MEDIUM TO COARSE SAND WITH 10% FINE QTZ PEBBLES (SOME IRON STAINS)	SS-2	2 5 5 9 R=1.0	Ø ppm OVA
6		6.0-9.0 LIGHT BROWN TO BROWN MEDIUM TO COARSE SAND WITH 15% FINE TO MEDIUM QUARTZ PEBBLES			
9		9.0-11.0 LIGHT BROWN TO TAN MEDIUM TO COARSE SAND WITH IRON STAINING ON SOME GRAINS. SLIGHTLY MOIST.	SS-3	5 5 5 6 R=0.7	Ø ppm OVA
11		11.0-14.0 SAA			
14	▽	14.0-16.0 SATURATED LIGHT BROWN MEDIUM TO COARSE SAND WITH IRON STAINED GRAINS AND TENDRILS OF STAINING	SS-4	0.5 0.5 1 2.5 R=2	Ø ppm OVA
16		16.0-19.0 SAA			
19					

BORING LOG GENERAL DATA
Borehole Number: E3-P13-M01
Page: 2 of 1 of 2 Signature: [signature]
Sent to USATHAMA: Date Sent:
Xerox:

BOR... LOG GENERAL DATA
Borehole Number: E3 - P13 - MC1
Page: 2 of 2
Signature: [illegible] Xeric
Sent to USATHAMA:
Date Sent:
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Project: SUDBURY ANNEX

Boring: E3-P13-MC1

Page: 4 of 5

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
19		19.0-21.0 SAA WITH MINOR CLAY LENSES.		2 5 6 5 R = 1	0.25 ppm OVA
21		21.0-23.0 SAA, NO CLAY, 10% FINE MICA FLAKES			RUNNING SANDS AT ≈ 20' TD (DRILLED) 23' TD (OPEN HOLE) 20'
23		TD BOREHOLE			SAMPLE 19-21'-BX1301X1

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BORING LOG GENERAL DATA

Project: Sudbury Annex Boring: E3-P11-MØ1 Page: 3 of 5

Driller & Company: Dave Gagne / ESD

Geologist/Logger & Company: John Pasch / E+E Signature:

Date Boring Started: 8/2/93 Completed: 8/2/93

Water Levels (from Ground Surface) Drilling Rig: Mobil

First Encountered: 14' Date: 8/2/93

While Drilling: 14' Date: 8/2/93

At Boring Completion: 14' Date: 8/2/93

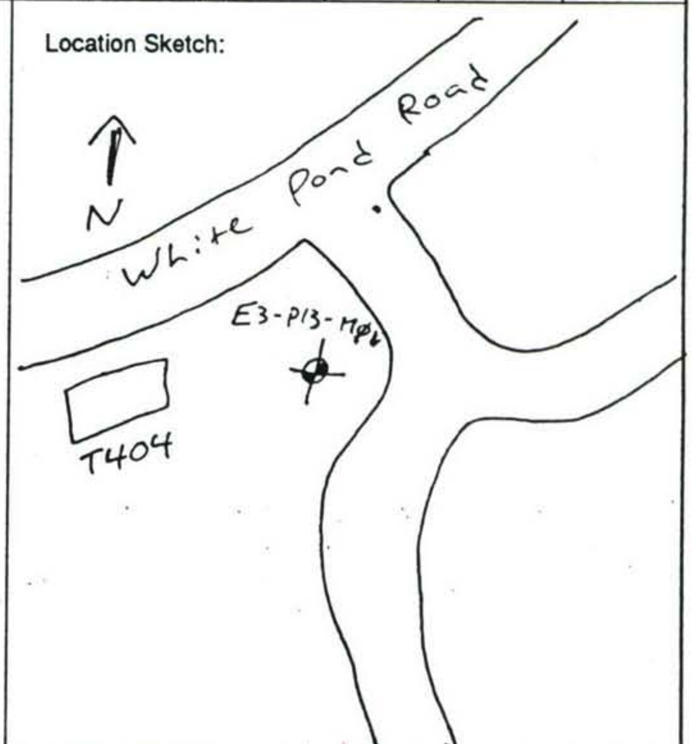
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/2	1627	1737	0'	23'					

Abbreviations:

Abbr.	Meaning
SS	Split Spoon
R	Recovery
F	Fine
M	Medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______ Page: 1 of ______ Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

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SUDBURY ANNEX 4

WELL CONSTRUCTION LOG

Page: 1 of ~~2~~

Site ID:
Well Number: E3-PB-M02
Job Number:
Today's Date: 8/3/93
Well Start/Completion Dates: 8/3/93, 8/3/93

Installation Difficulties: RUNNING SILT AT BOTTOM

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC
Schedule: 40
Type: Continuous Slot HORIZONTAL
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'

Screened Interval: 8-18'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES INC
Schedule: 40
Material: Stainless Steel
PVC X
Other

Length:

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED
Composition PVC
Depth(s) 8.0'

Centralizer: Design
Composition N/A
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)

Protective Casing: Material HARDENED STEEL
Inner Diameter 6"

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WELL CONSTRUCTION LOG
Well Number:
Page 1 of 3
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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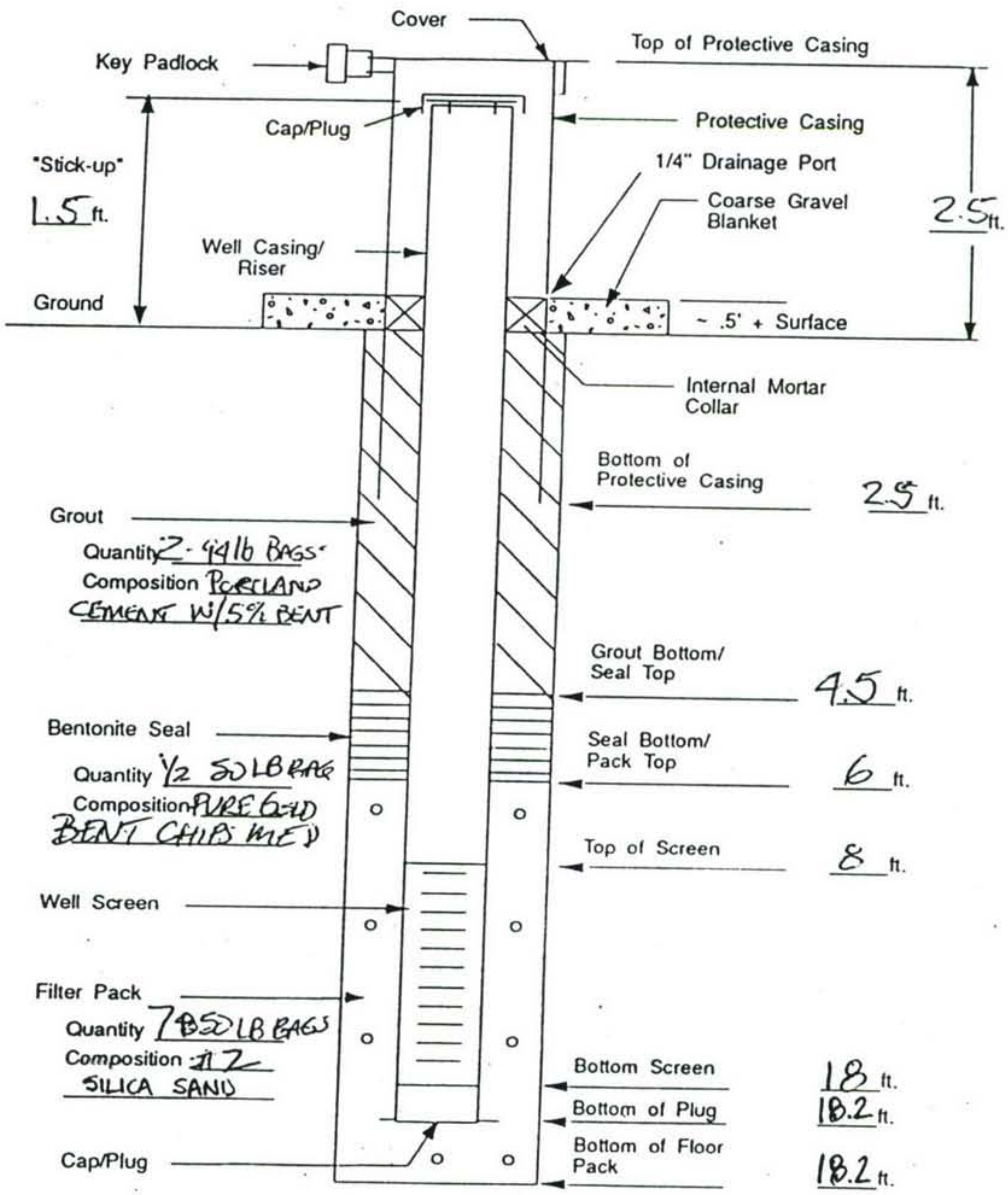
Well Construction Log:

Site ID Number:

Well Number: E3-P13-M02

Today's Date: 8/3/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-P13-M02

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Signature:

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Date Sent:

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Project: SUDBURY ANNEX | Boring: E3-P13-M02 | Page: 3 of 4

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description 8/3/94 START/FINISH-1045/13:20 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		SS1 DARK, SILT W/ROOTS .2' REST OF SPOON DRY BROWN GRAVELLY SAND GRAVEL .25-1" qtzite, granodiorite, phyllite-sand CS/MED/FN = 20/60/20	1050 R=.5	2 4 6 5	NOTE: 1/ SPLIT SPOONS DRIVEN W/140LB HAMMER W/30" FREE FALL 2/ DEPTH & "R" IN FT 3/ 8 1/4" HSA 4/ 2"x2' SPLIT SPOON
2					
4	▽	H2O depth = 4.0' SS2 GREY BR. WET GRAVELLY SAND GRAVEL UP TO 1" diam GRANODIORITE, QTZITE, PHYLLITE GRAVEL SUBANGULAR FN/MED/CS SND = 30/40/20	1100 R=.9	10 8 9 6	DRILLING NOTES 1/ DRIVE SPL. SP 0-2' 2/ AUGER TO 4' 3/ DR SPL SP 4-6'
6					
9		SS3 WET GREY FN MED GR SND W/GRAVEL ~~& FINES~~ GRAVEL SUBANGULAR QTZ, QTZITE, GRANODIORITE SAND MED/FN/CS 50/45/5 MINOR MICACEOUS GRAINS	1107 R=1.0	2 2 2 3	4/ H2O depth = 4' 5/ Auger to 9' 6/ Dr. Spl. spoon 9-11 7/ AUGER TO 14 8/ SPL SP 14-16' * 9/ AUGER TO 18'
11					
14		SS4 - MED FN GRAINED GREY SAND M/F/C 60/30/10, minor SUBROUNDED GRAVEL QZ QTZITE GRANODIORITE, PHYLLITE	1120 R=.6	1 1	10/ INSTALL WELL -14.6 -15.6
16					* LAST SPOON TOOK 1 BLOW FOR ~~2ND FOOT OF~~ 1.5 TO 2.5 FEET OF SPOON
18		TD: 18'			SAMPLE 9'-11' BX1302X1

BORING LOG GENERAL DATA
Borehole Number: E3-P13-M02
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Signature:
Sent to USATHAMA:
Date Sent:
Xerox: [illegible] 5/12

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BORING LOG GENERAL DATA

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Project: SUDBURY ANNEX Boring: E3 P13-MO 2 Page: X of X

Driller & Company: MARK THIBODEAU / ES

Geologist/Logger & Company: W GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/3/93 Completed: 8/3/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A300

First Encountered: 4.0' Date: 8/3/93

While Drilling: 4.0' Date: 8/3/93

At Boring Completion: 4.0 Date: 8/3/93

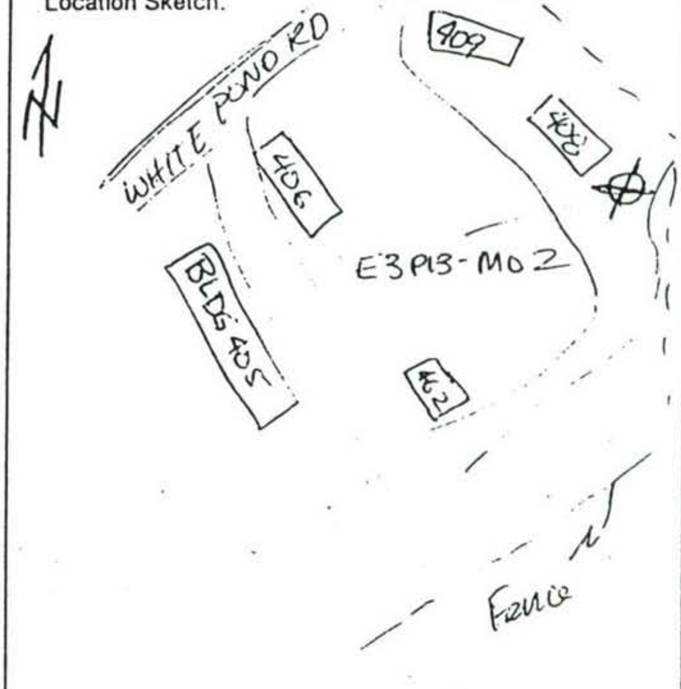
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/3	1045	1320	0	18					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BC 3 LOG GENERAL DATA
Borehole Number:
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Signature:
Sent to USATHAMA:
Date Sent:
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WELL CONSTRUCTION LOG

Site ID: SUDBURY
Well Number: E3-P13-M03
Job Number:
Today's Date: 8/3/93
Well Start/Completion Dates: 8/3/93 , 8/3/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES
Schedule: 40
Type: Continuous Slot HORIZONTAL SLOT
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'
Screened Interval: 8-18'
Diameter: (ID) 4" (OD) 4 1/2"
Thickness: ~~3~~ 1/4"
Slot: Size (inches): .02 Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES
Schedule: 40
Material: Stainless Steel
PVC X
Other
Length: 10'
Diameter: (ID) 4" (OD) 4 1/2"
Thickness: 1/4"
Joint(s): Design THREADED
Composition
Depth(s) 8.0'
Centralizer: Design N/A
Composition
Depth(s)
Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)
Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

WELL CONSTRUCTION LOG
Well Number:
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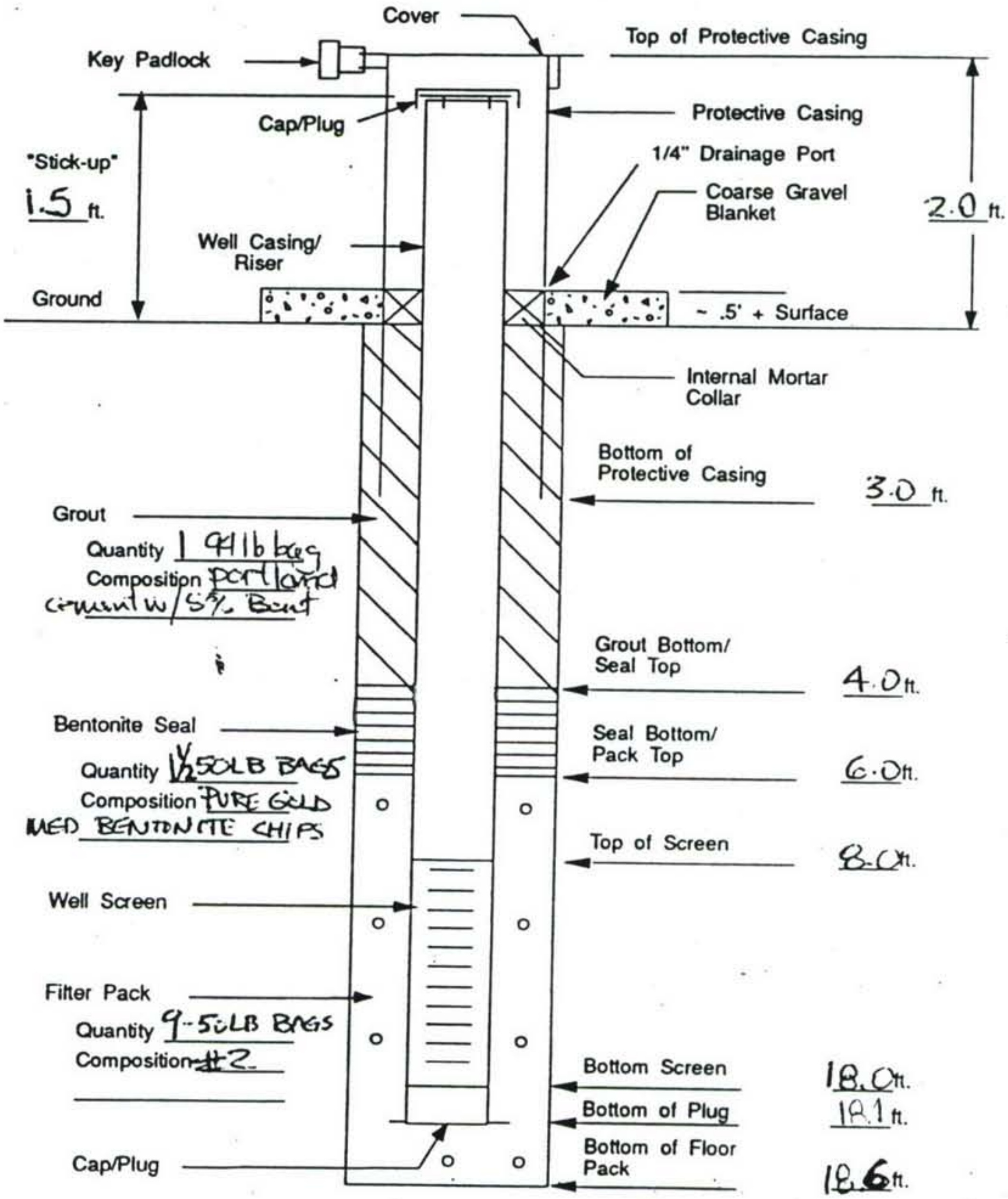
Well Construction Log:
Site ID Number: P13
Well Number: E3 P13 MD3
Today's Date: 8/3/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number:
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Page 2 of 3
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX | Boring: E3-P13-M-3 | Page: ~~1~~ 3 of 4

B-6

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (8/3/93; START/FINISH – 0805/1330; GROUND SURFACE)	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		SS1 TOP .2' – DK BR SILTY SND GRADING TO FN GR SAND – TAN (.2–.7') .7–1.1 BROWN FN GR SN GRADING TO MED SND TAN WITH GRAVEL OF QTZITE, PHYLLITE. WHOLE SPOON DRY + SLIGHTLY MOIST OVA 0.0ppm	0805 R=1.1	4 5 6 5	NOTE: 1/ SPLIT SPOON DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL 2/ DEPTH & "R" IN FEET 3/ 8 1/4 HSA 4/ 2" x 2' SPLIT SPOON
2					
4	▽ 5.5'	MOIST SS2 MED SND TAN W/GRAVEL OF QTZITE, PHYLLITE 50% ~~ct~~ GRADING TO MED FN GR W/MINOR GRAVEL MED/FN = 50/50. BOTTOM OF SPOON FN GR SND TAN WET OVA 0.0 ppm WET @ ≈ 5.5'	0820 R=1.5	3 3 3 4	DRILLING NOTES 1/ DR SPL SP 0–2' 2/ AUGER TO 4' 3/ DR SPL SP 4–6' 4/ H_2O ≈ 5.5'
6					
9		SS3 WET, GREY, SILTY SND. ORANGE BAND OF SILTY SAND .2' WIDE ~~at~~ at ≈ 9.5'. REMAINDER OF SPOON GREY SILTY SND SAMPLES COLLECTED – TOC & GR SIZE OVA – 0.0ppm	R=1.4 0824	3 4 3 4	5/ AUGER TO 9' 6/ DR SPL SP 9–11' 7/ AUGER TO 14' 8/ DR SPL SP 14–16' 9/ AUGER TO 18'
11					
14		SS4 100% WET, GREY, SILTY SAND, PLASTIC, HOMOGENEOUS OVA – 0.0 ppm	R=1.8	WEIGHT HAMMER 3	WEIGHT OF ROD 14–15 WEIGHT OF ROD 15–15.6 WEIGHT OF H 15.6–16.3 10/ INSTALL CASING 11/ COMPLETE WELL
16					
18		18' = TD			SAMPLES BX1303X1 – GR SIZE, TOC 9–11'

Page: 2 of

Sent to USATHAMA: ______ Date Sent: ______

Signature: Walter Grof Xerox: ______

BORING LOG GENERAL DATA

Borehole Number: E3-P13-M03

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BORING LOG GENERAL DATA
Borehole Number:
Page: 1 of
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:
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BORING LOG GENERAL DATA

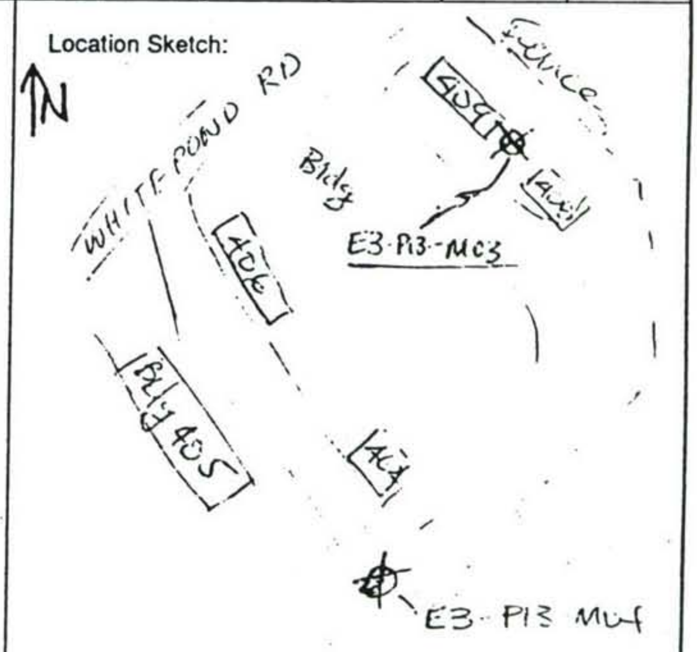
Project: SUDBURY ANNEX	Boring: ~~E3-P13-M02~~ 305 E3-P13-M03 Page: ~~1~~ 4 of ~~1~~ 4
Driller & Company: MARK THIBODEAU/ESI	
Geologist/Logger & Company: WALTER GRAF / E & E	Signature: Walter Graf
Date Boring Started: 8/3/93	Completed: 8/3/93
Water Levels (from Ground Surface)	Drilling Rig:
First Encountered: 5.5'	Date: 8/3/93
While Drilling:	Date: 8/8/93
At Boring Completion: 5.5	Date: 8/8/93
Drilling Shifts: 1	

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/3	0805	1330	0'	18.6'					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R=	RECOVERY

Location Sketch:



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WELL CONSTRUCTION LOG

Page: 1 of 3 4

Site ID: ______

Well Number: E3-P13-M04

Job Number: ______

Today's Date: 8/2/93

Well Start/Completion Dates: 8/2 / 8/2

Installation Difficulties: ______

Remarks: ______

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC

Schedule: 40

Type: Continuous Slot HORIZONTAL SLOT

Perforated ______

Louvre ______

Other ______

Materials: Stainless Steel ______

PVC ✓

Other ______

Length: 10'

Screened Interval: ~~8-18.6~~ 8.6-18.6'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 1/4"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES

Schedule: 40

Material: Stainless Steel ______

PVC X

Other ______

Length: 10 FEET

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREDED

Composition PVC

Depth(s) 8.6

Centralizer: Design N/A

Composition

Depth(s) ______

Solvent, Glues, Cleaners: Manufacturer N/A

Use(s) ______

Protective Casing: Material HARDENED STEEL

Inner Diameter 6"

WELL CONSTRUCTION LOG

Well Number: E3-P13-M04

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Page 1 of 3

Signature: ______

Xerox: ______

Sent to USATHAMA: ______

Date Sent: ______

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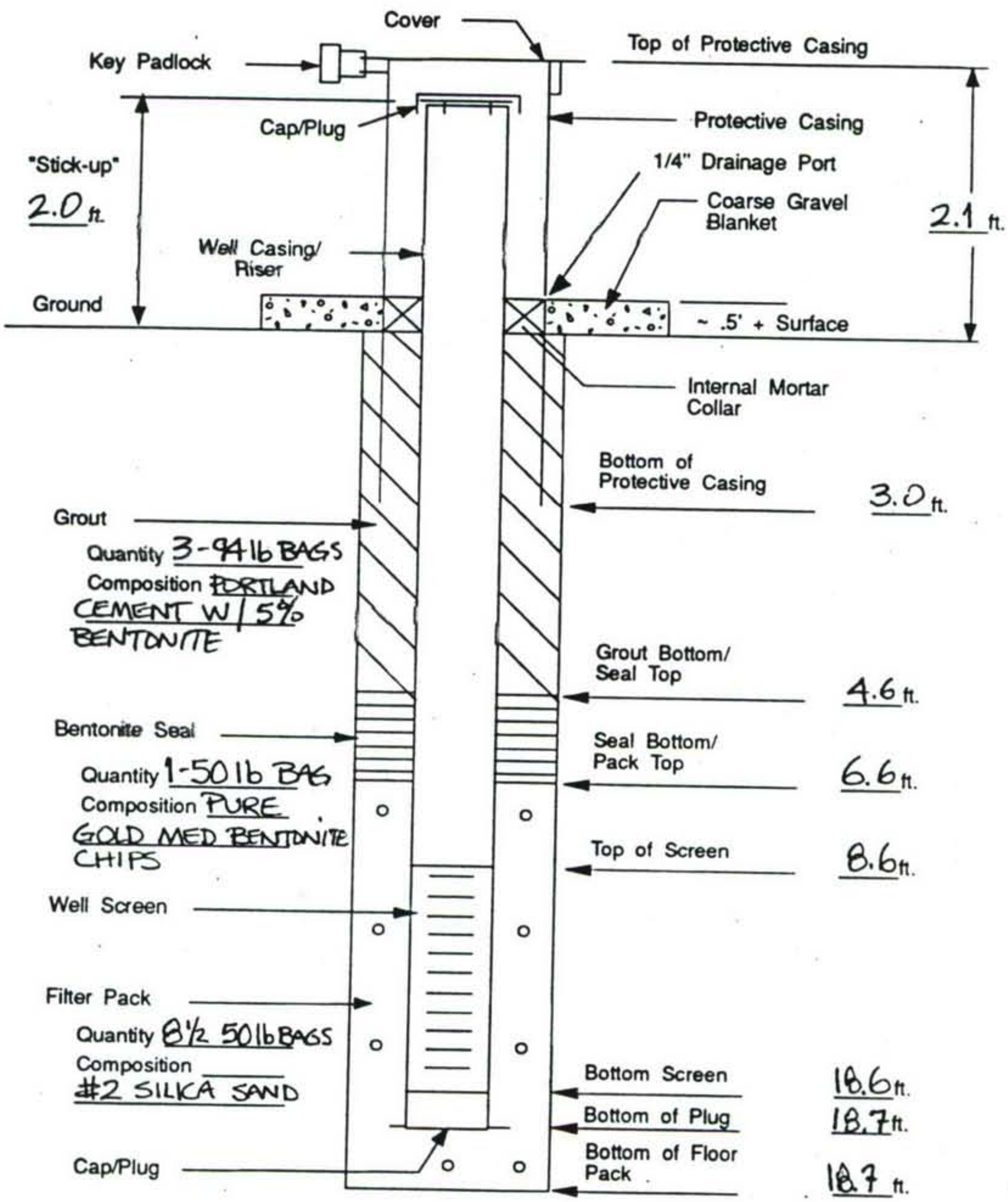
Well Construction Log:
Site ID Number: P13
Well Number: E3-P13-M04
Today's Date: 8/2/93

WELL CONSTRUCTION



Project: SUDBURY ANNEX | Boring: E3-P13-M04 | Page: 3 of 4

8/2/93

START/FINISH – 1618/1855

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
		SS1 0-2' YELLOW-BROWN SILTY SAND MINOR MED SAND (<5%)	R=.5' 1620	6 65 6 6	NOTE: 1/SPLIT SPOON DRIVEN W/ 140 LB HAMMER W/ 30" FREE FALL 2/ DEPTHS IN FT 3/ R IN FEET 4/ 8¼" HSA 5/ 2"x2' SPLIT SP
2		0.0 ppm OVA			
4		SS2 TAN MED-GR SND, MOIST TO VERY MOIST AT BOTTOM OF SPOON <10% CS GR, 2 FE BANDS @ 5.5'	R=1.1 1652	5 6 7 7	DRILLING NOTES 1/ DRIVE SPL SP. 0-2 2/ AUGER TO 4' 3/ DRIVE SS 4-6' 4/ AUGER TO 9' 5/ H_2O ≈ 9' 6/ DRIVE SS 9-11 7/ AUGER TO 14' 8/ DRIVE SS 14'-16' 9/ AUGER TO 18' 10/ INSTALL SCREEN 8-18'
6	▽	OVA 0.0 ppm			
9	9	TOP OF SPOON WET CS GRAINED SAND W/ GRAVEL QTZ ITE, PHYLLITES .3-1.2 FT = WET GREY ~~SILT~~ SILT W/ CLAY TIGHT, PLASTIC, HOMOGENEOUS	R-1.2 1700	6 6 8 8	
11	11	0.0 ppm OVA SS-3			
14		FN GRAINED, WET, GREY SAND ~~WET~~ HOMOGENEOUS	1710 R=.4	3 3 4 3	
16		OVA = 0.0 ppm SS4			SAMPLE 9-11' BX1304X1
18		TD = 18'			

BORING LOG GENERAL DATA
Borehole Number: ____ Page: 2 of ____ Signature: ____ Xerox: ____ Sent to USATHAMA: ____ Date Sent: ____

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usagndat.pm4

BORING LOG GENERAL DATA

4 4

Project: Sudbury Annex | Boring: E3-P13-MC4 | Page: 1 of 1

Driller & Company: MARK THIBODEAU / ENVIRONMENTAL STRUCTURAL DRILLING

Geologist/Logger & Company: W. GRAF / E&E | Signature: Walter Graf

Date Boring Started: 8/2/93 | Completed: 8/2/93

Water Levels (from Ground Surface) | Drilling Rig: Ingersoll-Rand A-300

First Encountered: ≈ 9 | Date: 8/2/93

While Drilling: ≈ 9 | Date: 8/2/93

At Boring Completion: 9 | Date: 8/2/93

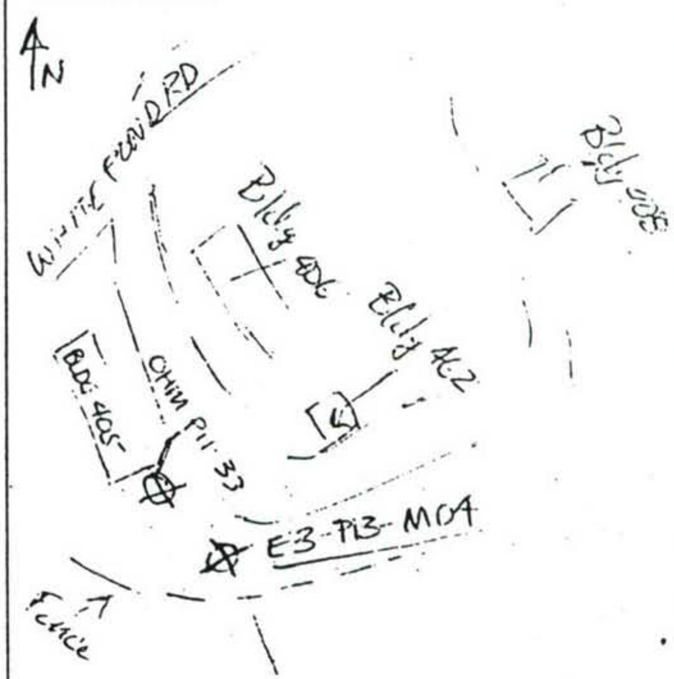
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/2/93	1618	1555	0	18.6					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R =	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: E3-P13-MC4
Page: 1 of
Signature: Walter Graf Xerox:
Sent to USATHAMA: Date Sent:

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usagndat.pm4

WELL CONSTRUCTION LOG
Page 1 of 3
Sent to USATHAMA: ______
Xerox: ______
Date Sent: ______
Signature: ______
Well Number: ______
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WELL CONSTRUCTION LOG

Page: 1 of

Site ID: SUDBURY ANNEX
Well Number: E3-P23-M01
Job Number:
Today's Date: 8/4/93
Well Start/Completion Dates: 8/4/93, 8/4/93

Installation Difficulties: NONE

Remarks: ~~SER~~ TOP OF SCREEN IS APPROXIMATELY 3' ABOVE THE WATER TABLE. H_2O Depth = 13.0'

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISE INC
Schedule: 40
Type: Continuous Slot HORIZONTAL
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'
Screened Interval: 19.6' → 9.6'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Slot: Size (inches): .020 Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

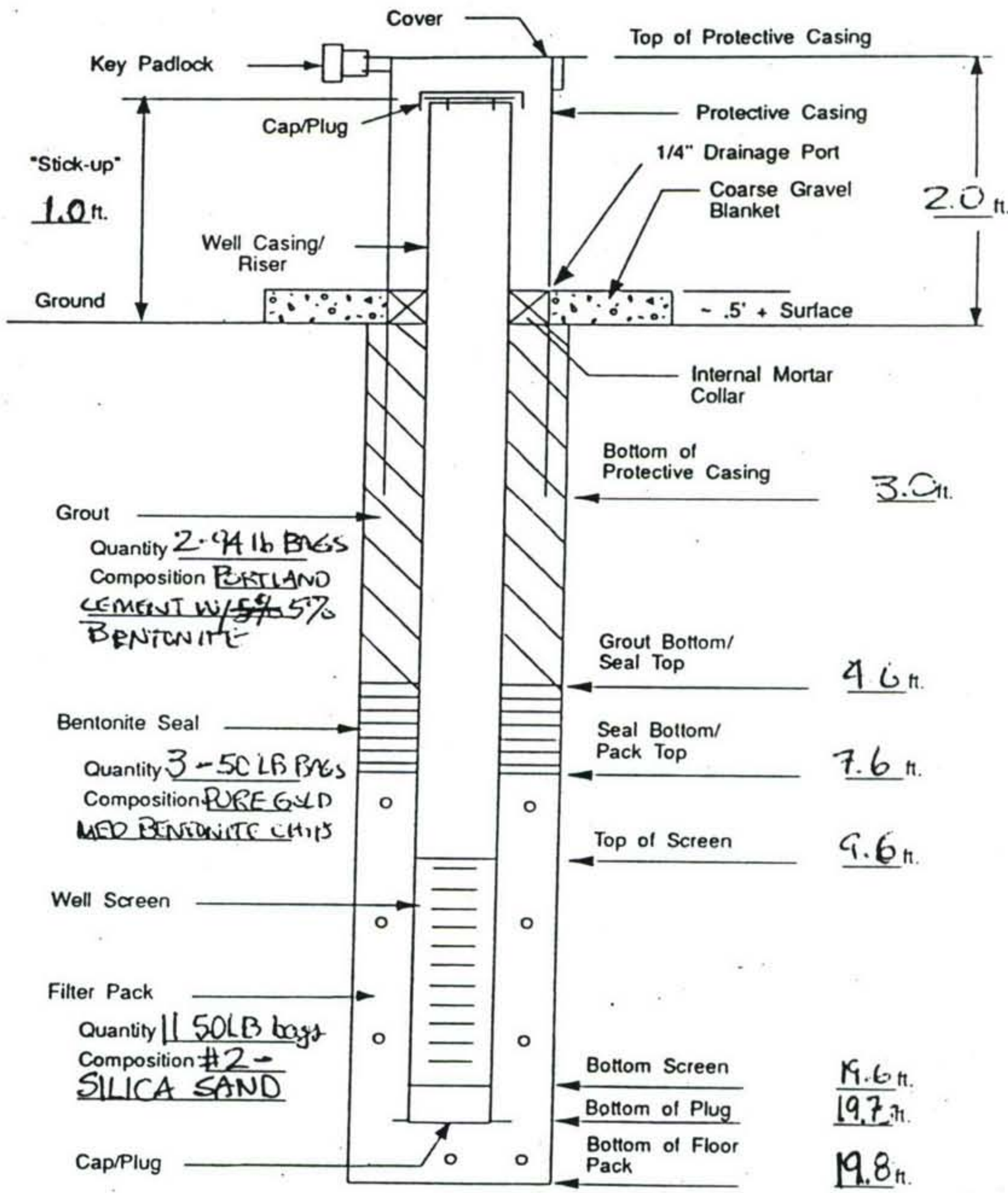
Casing

Manufacturer: BEDROCK ENTERPRISES INC
Schedule: 40
Material: Stainless Steel
PVC X
Other
Length: 1
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25'
Joint(s): Design THREADED
Composition PVC
Depth(s) 9.6'
Centralizer: Design N/A
Composition
Depth(s)
Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)
Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

usain

Well Construction Log:
Site ID Number: P23
Well Number: E3-P23-MO1
Today's Date: 8/4/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-P23-MO1
Page 2 of 3
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX | Boring: E3-P23-M01 | Page: 3 of 4

8/4/93

START/FINISH - 0851/1050

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
0–2		SS1 NO RECOVERY - MAY HAVE ~~HAD~~ WE PUSHED A ROCK. TOP 2' PROBABLY ROAD FILL	0853 R=0	5 9 16 18
4–6		SS2 TAN MED CS GR GRAVELLY SAND. GRAVEL SUBROUNDED GRANODIORITE, QTZITE, PHYLLITE. SAND ~~CS~~ MED/CS=70/30%. ORANGE MED SND @ ≈ ~~6~~ 5.0'	0905 R=1.0	5 8 11 17
9–11		SS3 CS MED SND W/GRAVEL MOIST, TAN. CS/MED 70/30 MINOR FINES. SMALL BAND OF WELL-SORTED GRAVEL (≈3mm gr size) AT 10.5 FT. THEN GRADING TO MED SND w/MINOR FINES, MOIST,	0915 R=1.1	5 4 6 5
13	▽	H_2O @ ≈13.0' BGS		
14–16		SS4 ~~BSP~~ 14-14.5' WET, BROWN MED-FN GRAINED SAND W/GRAVEL SUBANGULAR GRANODIORITE QTZITE PHYLLITE. 14.5'-16.0 - SANDY GRAVEL WET BR-SND/GR=25/75. SUB ROUNDED ~~ANGULAR TO~~ POORLY SORTED W/ SAME ROCK TYPES AS ABOVE	0925 R=1.5	6 3 4 7
19–21		SS5 POORLY SORTED SANDY GRAVEL AS ABOVE. 20' BROWN FN GRAINED SAND W/SILT. HOMOGENEOUS, TIGHT	0940 R=.7	2 2 3 3
		TD = 19.6		

Drilling Data

NOTES: 1/ SPLIT SPOONS DRIVEN W/ 140 LB HAMMER W/30" FREE FALL
2/ DEPTHS IN FT
3/ R IN FEET
4/ 8¼" HSA
5/ 2"x2' SPLIT SPOON

DRILLING NOTES:
1/ DRIVE SPL SP 0-2
2/ AUGER TO 4'
3/ DRIVE SPL SP 4-6'
4/ AUGER TO 9'
5/ DRIVE SPL SP 9-11'
6/ AUGER TO 14'
7/ DR SPL SP 14-16'
8/ H_2O @ ≈ 13.0'
9/ AUGER TO 19'
10/ DR SPL SP 19-21'
11/ TD = 19.8'
12/ INSTALL WELL.

SAMPLE
14-16' BX2301X1

BORING LOG GENERAL DATA
Borehole Number: E3 P23-M01
Page: 2 of
Signature: [signature] Xerox
Sent to USATHAMA:
Date Sent:

BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: P23-M01 Page: 4 of 4

Driller & Company: MARK THIBODEAU / ES

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/4/93 Completed: 8/4/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A300

First Encountered: 13.0 Date: 8/4/93

While Drilling: 13.0 Date: 8/4/93

At Boring Completion: 13.0 Date: 8/4/93

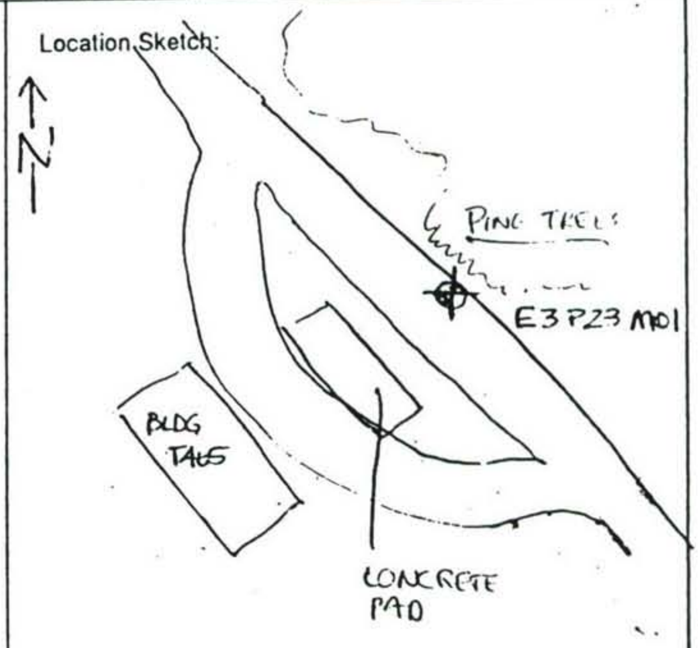
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/4	0851	~~1045~~ WG 1050	0	19.8					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA Borehole Number: ____ Page: 1 of ____ Signature: ____ Sent to USATHAMA: ____ Date Sent: ____ Xerox: ____

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WELL CONSTRUCTION LOG

Site ID:
Well Number: E3-P26-M01
Job Number: UC6066
Today's Date: 8/4/93
Well Start/Completion Dates:
8/4/93 / 8/4/93

Page: 1 of 3

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: Bedrock Enterprises Inc
Schedule: 40
Type: Continuous Slot Horizontal Slot, 1/4 inch spacing
Perforated ____
Louvre ____
Other ____

Materials: Stainless Steel ____
PVC X
Other ____

Length: 10 ft

Screened Interval: 8' - 18'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Slot: Size (inches): 0.020 Configuration: 1/4" Hor Slot

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: Bedrock Enterprises Inc
Schedule: 40
Material: Stainless Steel ____
PVC X
Other ____
Length: 10 ft
Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Joint(s): Design Threaded
Composition PVC
Depth(s) 8'

Centralizer: Design N/A
Composition
Depth(s)

Solvent, Glues, Cleaners: Manufacturer N/A
Use(s)

Protective Casing: Material Steel
Inner Diameter 6'

WELL CONSTRUCTION LOG
Well Number: ____
Page 1 of 3
Signature: ____
Xerox: ____
Sent to USATHAMA: ____
Date Sent: ____

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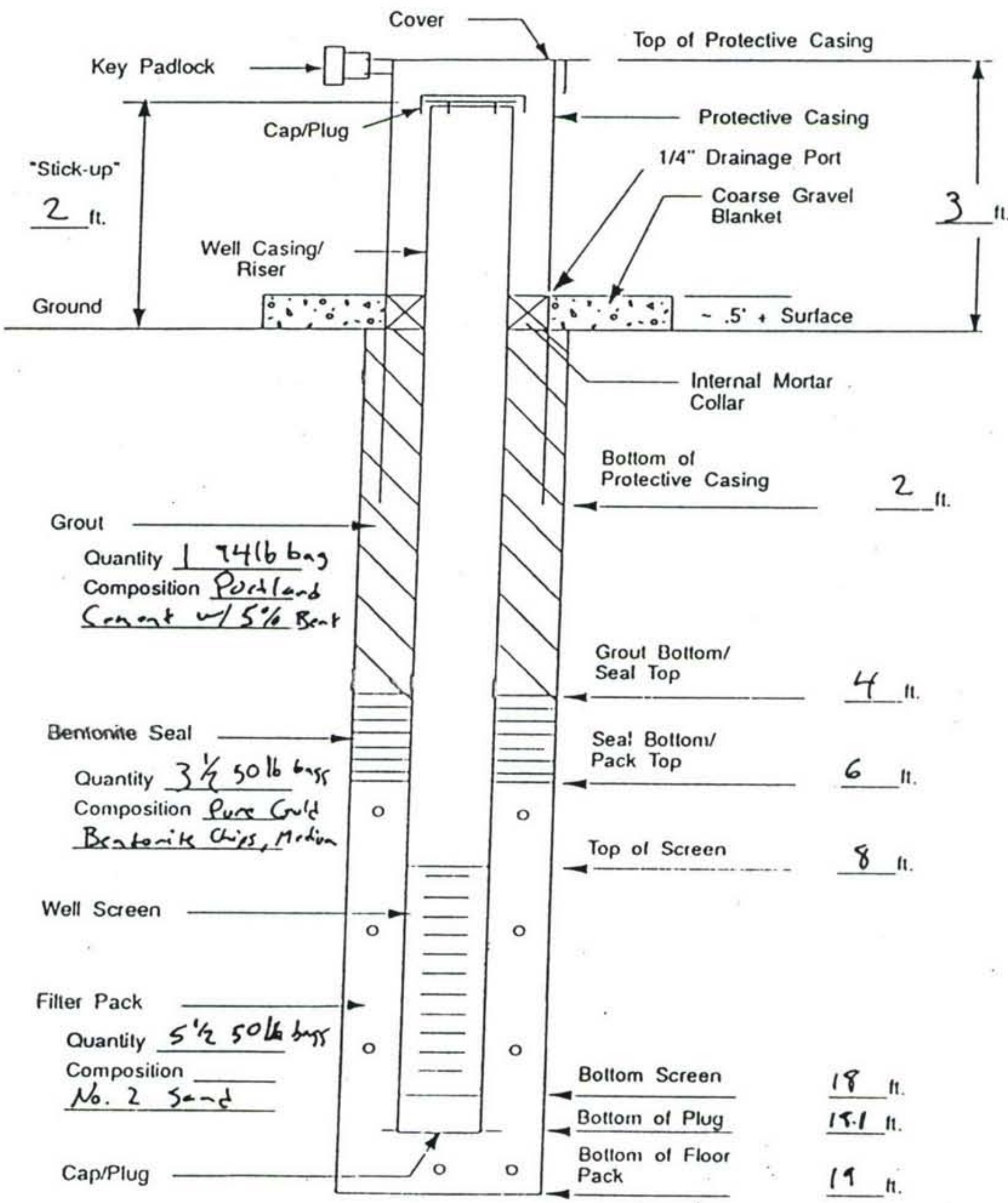
Well Construction Log: ______
Site ID Number: P26
Well Number: E3 - P26 - M01
Today's Date: 8/4/93

WELL CONSTRUCTION



Sent to USATHAMA: ______ Date Sent: ______
Page 2 of 3 Xerox: ______ Signature: ______
WELL CONSTRUCTION LOG Well Number: ______
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Project: SUDBURY ANNEX | Boring: E3-P26-M01 | Page: 3 of 4

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (GROUND SURFACE ORGANICS)	Sample Number & Depth	Blow Count & Recovery	Drilling Data 8/4/93 START/FINISH 1252/1342
		0.0 - 0.5 Dark brown, organic silty sand, friable (60% F)	SS-1	2	
		0.5 - 2.0 Tan med. to cs silty sand (20% F) w/10-20% med to cs pebbles.		6, 6, 6	Ø ppm OVA
2				R=0.5	
		2.0 - 4.0 Light brown to Dark brown med to cs sand (10% F) coarsens/darkens with depth. 20% fine to cs pebbles throughout.			
4		4.0 - 6.0 SAA alternating with gray med to cs sand and iron stained layers (≈ 4" thick).	SS-2	3, 12, 13, 10	Ø ppm OVA
6	▽			R=1.25	
		6.0 - 9.0 Medium brown to red-brown med. to v. cs. sand with 25% med pebbles of qtz and weathered phyllite. Wet			DRILLING NOTES: 1) DRIVE SPL SP 0-2'
9		9.0 - 11.0 Gray med to cs silty sand (20% fines) fines with depth. Some 1/8" iron stained layers. 10% fine pebbles with few cs pebbles. Wet		1, 2, 3, 6	2) AUGER TO 4' 3) DRIVE SPL SP 4-6' 4) AUGER TO 9' 5) DRIVE SPL SP 9-11
11		11.0 - 14.0 Gray fine to med silty sand (50% fines) with 10% fine pebbles, some mica flakes and weathered phyllite flakes		R=1.25	6) H_2O @ ≈6' 7) AUGER TO 14' 8) DRIVE SPL SP 14-16' 9) AUGER TO 19' TD = 19'
14		14.0 - 18.0 Gray-tan fine to med silty sand (50% F) with some (10%) fine pebbles. Wet			
18		18.0 - 19.0 Dark gray very fine silty sand (75% F) shows some cohesiveness (some clay)			SAMPLES 9-11' BX2601X1
19		TD BH			

BORING LOG GENERAL DATA
Borehole Number: E3-P26-M02
Sent to USATHAMA: Date Sent:
Page: 2 of
Signature: Xerox:
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BORING LOG GENERAL DATA

Project: Sudbury Annex Boring: E3-P26-MØ1 Page: ~~1~~ 4 of 4

Driller & Company: Dave Gagne/ESD

Geologist/Logger & Company: John Pasck/E&E Signature: [signature]

Date Boring Started: 8/4/93 Completed: 8/4/93

Water Levels (from Ground Surface) Drilling Rig: Mobile

First Encountered: 6' Date: 8/4/93

While Drilling: 6' Date: 8/4/93

At Boring Completion: 6.0' Date: 8/4/93

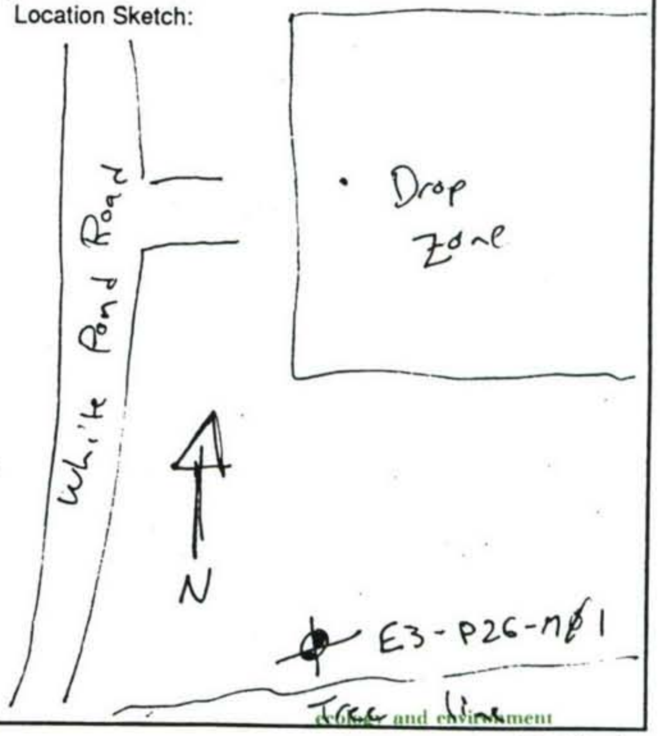
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/4	1252	1342	0'	19'					

Abbreviations:

Abbr.	Meaning
SS	split spoon
R	recovery
F	fine
M	medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______ Page: 1 of ______ Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

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recycled paper

Sent to USATHAMA: ____
Date Sent: ____
Xerox: ____
Page 1 of 3
Signature: ____

WELL CONSTRUCTION LOG

Site ID: ______

Well Number: E3-P26-MO2

Job Number: UC60066

Today's Date: 08/03/93

Well Start/Completion Dates:
08/03/93 / 08/03/93

Installation Difficulties: ~~Drill~~

Remarks: ______

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC.

Schedule: 40

Type: Continuous Slot HORIZONTAL SLOT, 0.25" SPACING
Perforated ______
Louvre ______
Other ______

Materials: Stainless Steel ______
PVC X
Other ______

Length: 10 FEET

Screened Interval: 9.0'-19.0'

Diameter: (ID) 4.0 INCH (OD) 4.5 INCH

Thickness: 0.25 INCH

Slot: Size (inches): 0.020 Configuration: ______

Open Area per Foot of Screen: 6.27 in^2/ft

Casing

Manufacturer: BEDROCK ENTERPRISES INC.

Schedule: 40

Material: Stainless Steel ______
PVC X
Other ______

Length: 10 FEET

Diameter: (ID) 4.0" (OD) 4.50"

Thickness: 0.25"

Joint(s): Design THREADED
Composition ______
Depth(s) ______

Centralizer: Design N/A
Composition ______
Depth(s) ______

Solvent, Glues, Cleaners: Manufacturer N/A
Use(s) ______

Protective Casing: Material STEEL
Inner Diameter 6 INCH

WELL CONSTRUCTION LOG
Well Number: ______
48

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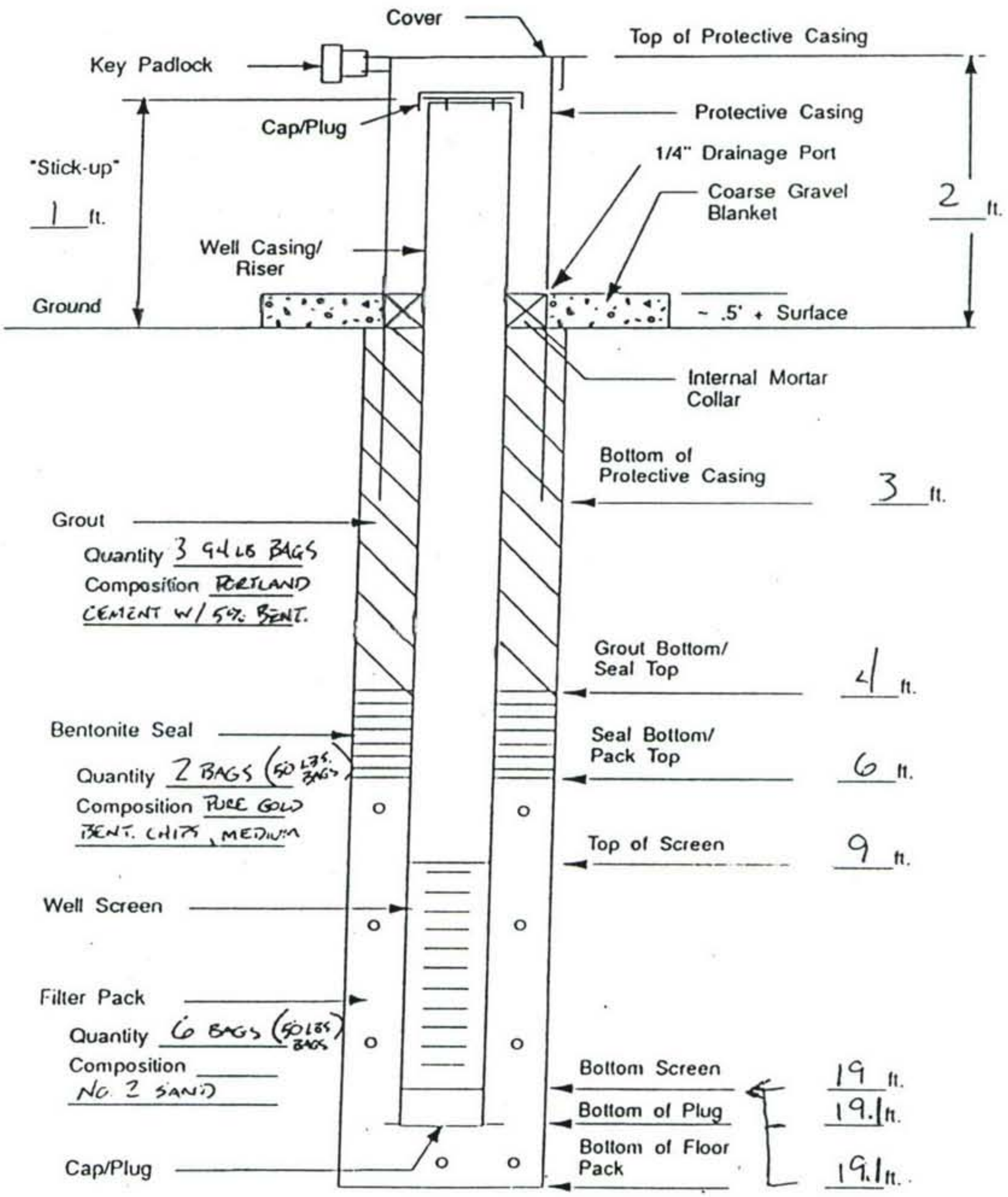
Well Construction Log:
Site ID Number: P26
Well Number: E3-P26-MO2
Today's Date: 08/03/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number:
Page 2 of 3
Signature:
Sent to USATHAMA:
Date Sent:
Xerox:

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Project: Sudbury Annex | Boring: E3-P26-M02 | Page: 3 of 4

8/3/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
0		GROUND SURFACE			Time Start = 1311 Time Complete = 1415
		0-0.3 Silty Sand; dark brn; low moisture; 40% F, 60% M; High Organics; some small gravels 0.3-1.0 Silty Sand - med. brn → lt brn; 10% F; 40% M, 50% C; 30-40% gravels up to ½" diam; iron staining.	SS1 0-2' OVA=0ppm	1, 5, 5, 12 R=1.0'	① 6¼" HSA ID ② 2" split spoons driven by 140 lb hammer w/ 30" free fall
2		Sand as above except increase in gravel content and size (up to 1" diam) - gravels go from subangular to subrounded.			HSA 0-4'
4		4.0-4.4' Silty Sand - lt brn; 40% F, 60% M, some small gravels, low moisture; 10-20% silt 4.4-5.0' Silty Sand - med. brn; high moisture; 40% M 60% C; some small gravels; <10% silt	SS2 4-6' OVA=0ppm	8, 7, 8, 11 R=1.0'	HSA 4-9'
6	∇	Sand as above - increase in moisture wet at ≅ 8' Decrease in gravel			
9		Silty Sand - gray brn, 60% F, 40% M; wet; <10% silt; iron stained laminations	SS3 9-11' OVA=0ppm	1, 1, 4, 3 R=1.5'	HSA 9-14'
11		Sand as above except gray			
14		slight increase in % fines			
19					
					SAMPLE BX2602X1 9-11'

ING LOG GENERAL DATA
Borehole Number: ______
Page: 2 of ______
Signature: ______
Sent to USATHAMA: ______ Date Sent: ______

BORING LOG GENERAL DATA

Project: Sudbury Annex Boring: E3-P26-MØ2 Page: ~~1~~ 4 of 4

Driller & Company: Dave Gagne / ESD

Geologist/Logger & Company: John Pasch / E+E Signature: [signature]

Date Boring Started: 8/3/93 Completed: 8/3/93

Water Levels (from Ground Surface) Drilling Rig: Mobile

First Encountered: 8.0' Date: 8/3/93

While Drilling: 8.0' Date: 8/3/93

At Boring Completion: 8.0' Date: 8/3/93

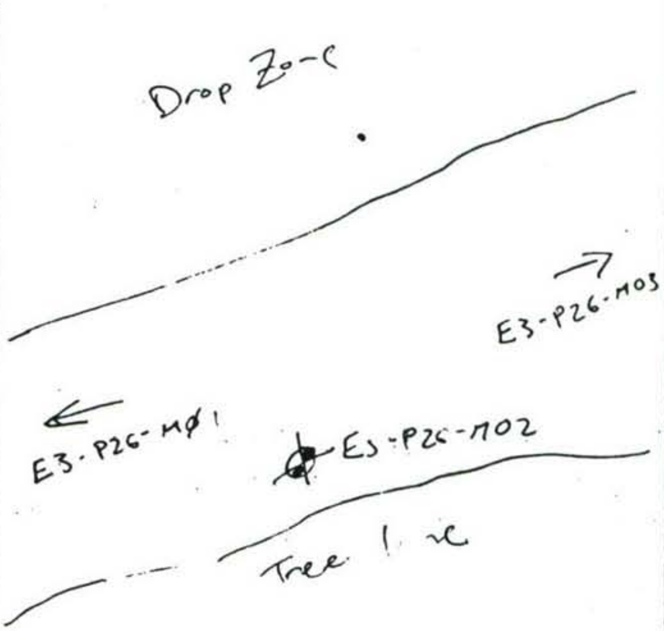
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/3/93	1311	1415	0	19.1					

Abbreviations:

Abbr.	Meaning
SS	Split spoon
R	recovery
F	fine
M	medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______ Page: 1 of ______ Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

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SUDBURY ANNEX

WELL CONSTRUCTION LOG

Site ID:

Well Number: E3-P26-M03

Job Number: UC6066

Today's Date: 8/4/93

Well Start/Completion Dates: 8/4/93 / 8/4/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: Bedrock Enterprises Inc.

Schedule: 40

Type: Continuous Slot Horizontal Slot, 1/4" spacing

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10 ft

Screened Interval: 8.0' - 18.0'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Slot: Size (inches): 0.020 Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 inches²/ft

Casing

Manufacturer: Bedrock Enterprises Inc.

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Joint(s): Design Threaded

Composition

Depth(s)

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer N/A

Use(s)

Protective Casing: Material Steel

Inner Diameter 6"

WELL CONSTRUCTION LOG
Well Number:
Page 1 of 3 Signature:
Xerox:
Sent to USATHAMA:
Date Sent:
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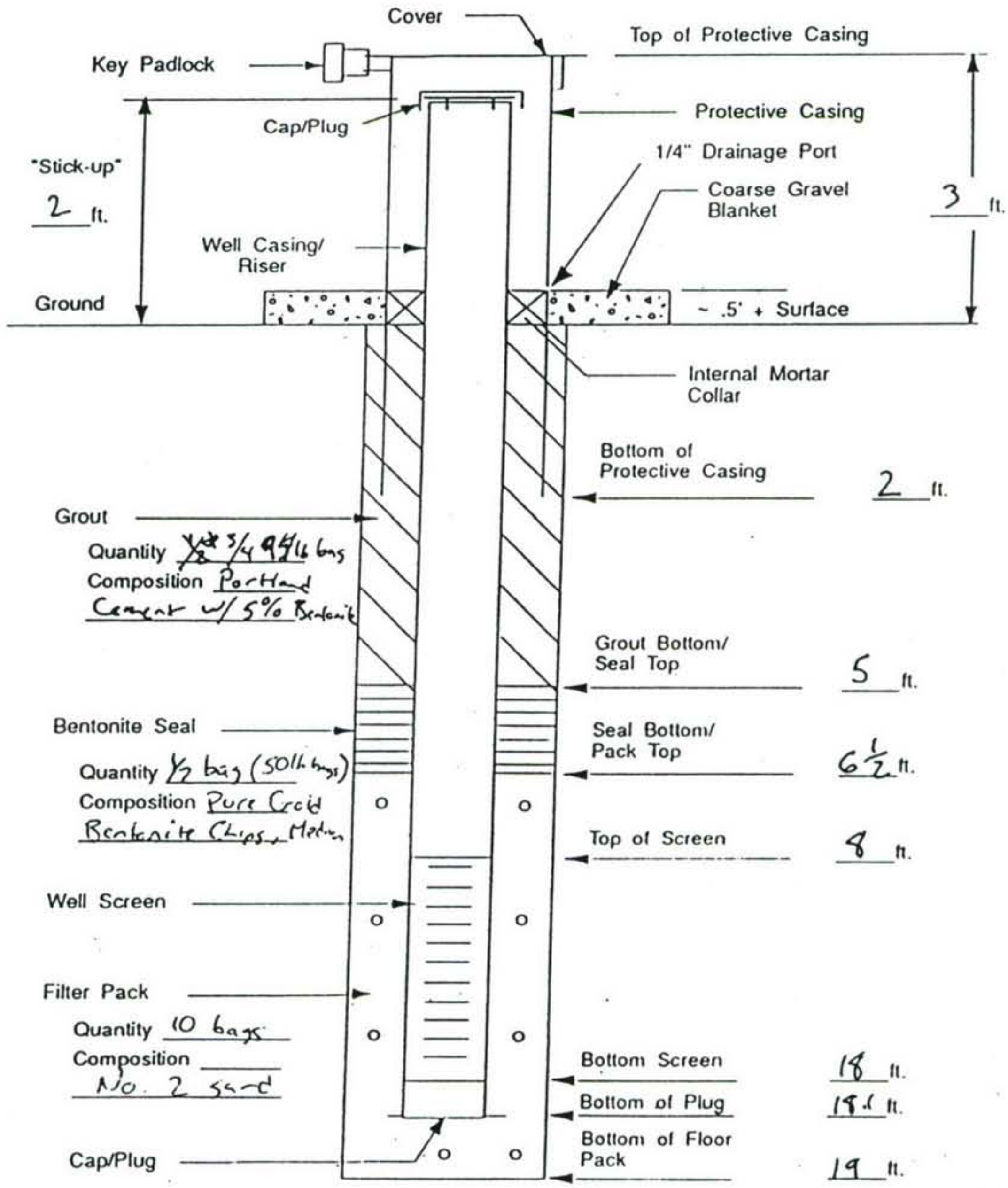
Well Construction Log:

Site ID Number: P26

Well Number: E3 - P26 - M03

Today's Date: 8/4/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number:

Page 2 of 3
Signature:

Xerox:

Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX			Boring: E3-P26-M03		Page: 3 of 4
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description GROUND SURFACE ORGANICS	Sample Number & Depth	Blow Count & Recovery	Drilling Data 8/4/94 START/FINISH 0857/0940
		0.0 - 0.5 Organic silty sand, dark brown, friable	SS-1	4 6 8 8 R=1.0	∅ ppm OVA
		0.5 - 2.0 Tan, med to cs sand w/ 20% fine to med pebbles.			
2		2.0 - 4.0 Medium Brown, med to cs clean sand (<10% F) with 10-20% fine to med pebbles.			
4		4.0 - 6.0 SAA, pebbles coarsening with depth. Note 1/2" dark brown organic layer at 5.4' BGS	SS-2	4 8 10 10 R=1.0	∅ ppm OVA
6	▽	6.0 - 9.0 SAA, wet			
9		9.0 - 11.0 Orange and tan medium sand in alternating bands ~ 4" wide with minor 1/4" organic layers. Wet.	SS-3	2 2 3 3 R=0.8	∅ ppm OVA
11		11.0 - 15.0 Medium brown to Tan medium to coarse sand w/ 10-20% fine pebbles, some cs orange grains. Wet.			
15		15.0 - 16.0 SAA 16.0 - 19.0 Dark grey very fine silty sand (75% F) shows some cohesiveness (some clay). Wet.			
19		TD BH			SAMPLE BX2603X1 9-11'

BORING LOG GENERAL DATA
Borehole Number: E3-P26-M03
Page: 1 of
Signature:
Sent to USATHAMA:
Date Sent:

BORING LOG GENERAL DATA

Project: Sudbury Annex | Boring: E3-P26-M03 | Page: 4 of 4

Driller & Company: Dave Gagne / ESD

Geologist/Logger & Company: John Pasch / E&E | Signature: [signature]

Date Boring Started: | Completed:

Water Levels (from Ground Surface) | Drilling Rig:

First Encountered: 6.0' | Date: 8/4/93

While Drilling: 6.0' | Date: 8/4/93

At Boring Completion: 6.0' | Date: 8/4/93

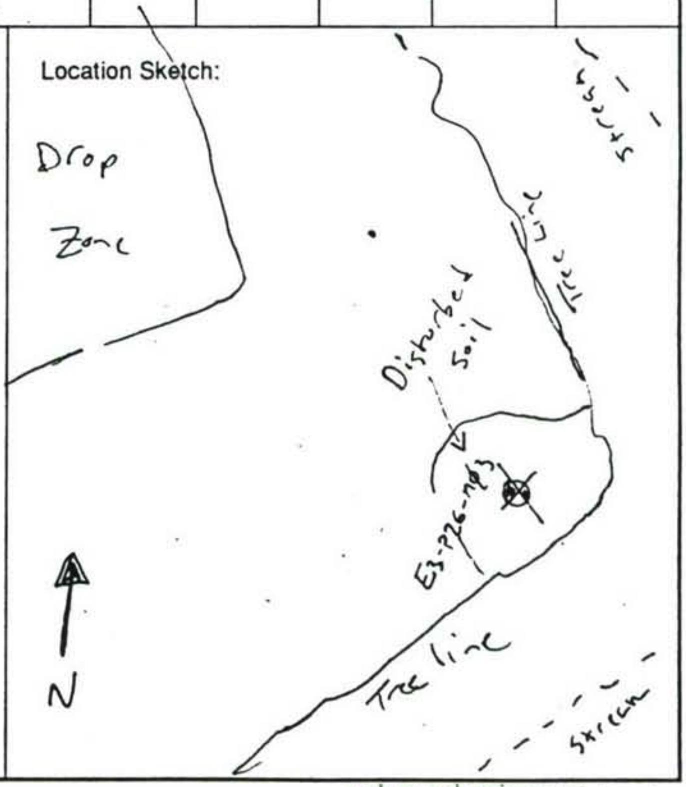
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/4	0857	0940	0'	19'					

Abbreviations:

Abbr.	Meaning
SS	split spoon
R	recovery
F	fine
M	medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number:
Page: 1 of
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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WATERSHED 2

GROUNDWATER MONITORING WELLS

E3-A10-M01
E3-P36-M01
E3-P36-M02
E3-P36-M03
E3-P37-M01
E3-P37-M02
E3-P37-M03

SUDBURY ANNEX 1

WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX

Well Number: E3-A10-MØ1

Job Number: UC606C

Today's Date: 8/12/93

Well Start/Completion Dates: 8/12/93 / 8/12/93

Page: ~~1~~ of 4

Installation Difficulties: ______

Remarks: ______

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Type: Continuous Slot HORIZONTAL

Perforated ______

Louvre ______

Other ______

Materials: Stainless Steel ______

PVC X

Other ______

Length: 10'

Screened Interval: 8.5' - 18.5'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Material: Stainless Steel ______

PVC X

Other ______

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED

Composition ______

Depth(s) 8.5'

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE

Use(s)

Protective Casing: Material HARDENED STEEL

Inner Diameter 6.0"

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Page 1 of 3 Xerox: ______ Sent to USATHAMA: ______

Signature: ______ Date Sent: ______

WELL CONSTRUCTION LOG

Well Number: ______

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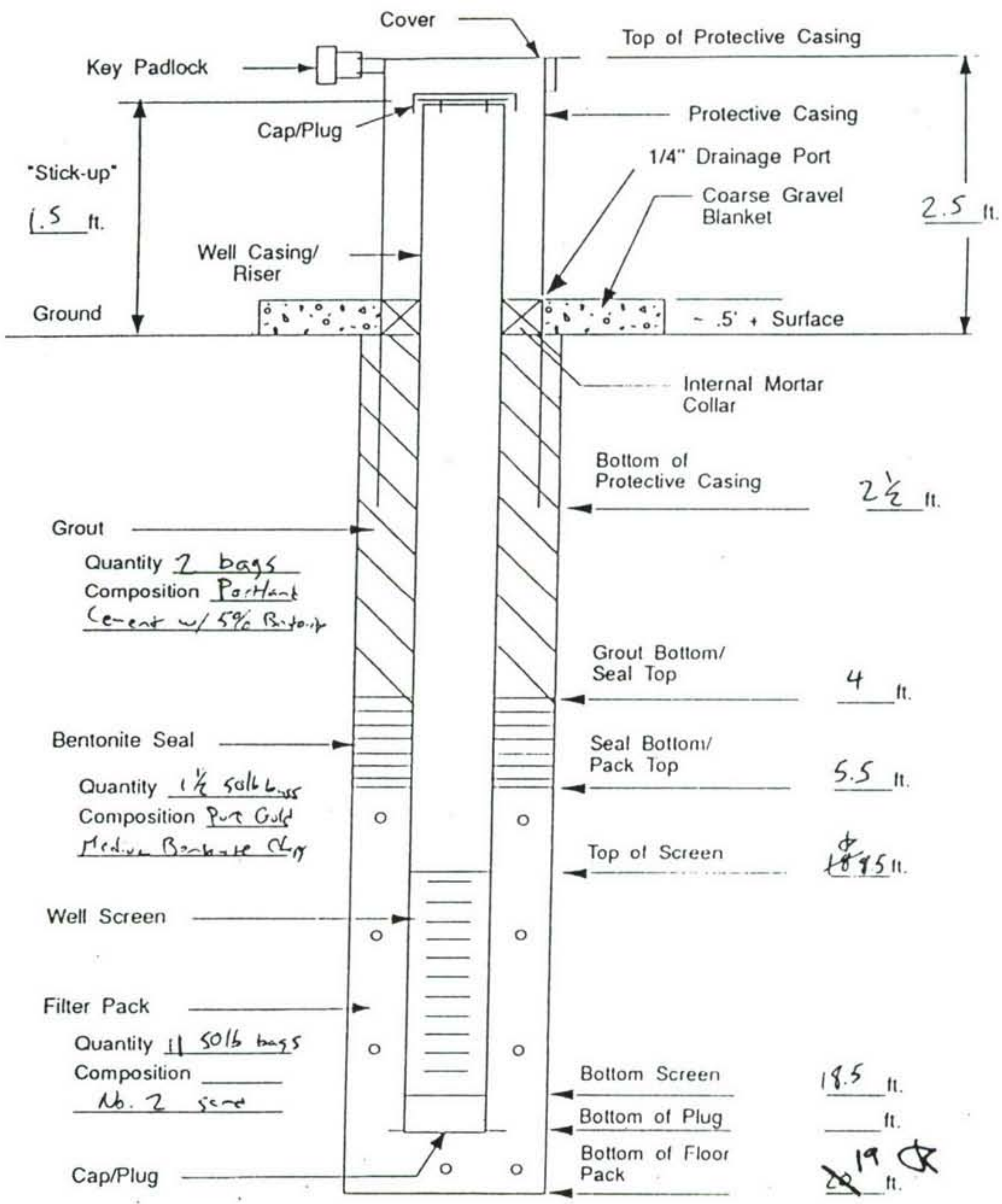
Well Construction Log: ______

Site ID Number: SUDBURY ANNEX

Well Number: E3-A10-MØ1

Today's Date: 8/12/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG

Well Number: ______

Page 2 of 3

Signature: ______

Xerox: ______

Sent to USATHAMA: ______

Date Sent: ______

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BORING LOG GENERAL DATA
Boring Number: E3-A10-MØ1
Page: 2 of
Signature:
Sent to USATHAMA:
Date Sent:
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Project: Sudbury Annex

Boring: E3-A10-MØ1

Page: 3 of 4

8/12/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			Time Start 1347 Time Stop 1437
0		0-0.4' Silty Sand; dk brown; low moisture; 40%F, 60%M; high organics. 0.4-0.8' Silty Sand; med brown → red brown; low moisture, 40%F, 60%C; minor organics; some small pebbles up to 1/8" diam	SS1 OVA = 0ppm	1, 1, 1, 3 0.8'R	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL 2/ DEPTH & R IN FEET 3/ 6 1/4 HSAs 4/ 2" X 2' SPLIT SPOONS
2		Sand as above except med brn			
4		4.0-5.0' Silty Sand; lt. brn; low moisture; 20%F, 60%M, 20%C; some coarse layering; 5-10% gravel up to 1/4" diam; iron stained layer. 5.0-5.5' Silty Sand; lt. brn; low moisture; 30%F, 60%M, 10%C; some iron staining	SS2 OVA = 0ppm	3, 8, 8, 11 1.5'R	
6					DRILLING NOTES 1) DRIVE SPL SP 0-2' 2) AUGER TO 4' 3) DRIVE SPL SP 4-6' 4) AUGER TO 9' 5) DRIVE SPL SP 9-11 6) H2O @ 10' 7) AUGER TO 14' 8) DRIVE SPL SP 14-16 9) AUGER TO 19' 10) TD-19'
9		Gravelly Sand; grey brown; moist → wet at ≅ 10'; 30%M, 70%C; 20-30% gravels up to 1/4" diam	SS3 OVA = 0ppm	3, 4, 5, 4 1.0'R	
10 ∇					
11					
14		14-14.8' - Sand as above except red brn; iron stained. 14.8-15.2 - Silty sand, 30%F, 60%M, 10%C; wet; red brn; some gravels up to 1/4" diam; iron stained	SS4 OVA = 0ppm	2, 2, 2, 6 1.2'R	
16		Sand as above			
19		TD = 19'			SAMPLE 14-16 BX1001X1

BORING LOG GENERAL DATA
Borehole Number:
Page: 1 of
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:
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BORING LOG GENERAL DATA

Project: Sudbury Annex Boring: E3-A10-MØ1 Page: 4 of 4

Driller & Company: Dave Gagne / ESD

Geologist/Logger & Company: John Pasch / E+E Signature:

Date Boring Started: 8/12/93 Completed: 8/12/93

Water Levels (from Ground Surface) Drilling Rig: Mobile

First Encountered: 10.0' Date: 8/12/93

While Drilling: 10.0' Date: 8/12/93

At Boring Completion: 10.0' Date: 8/12/93

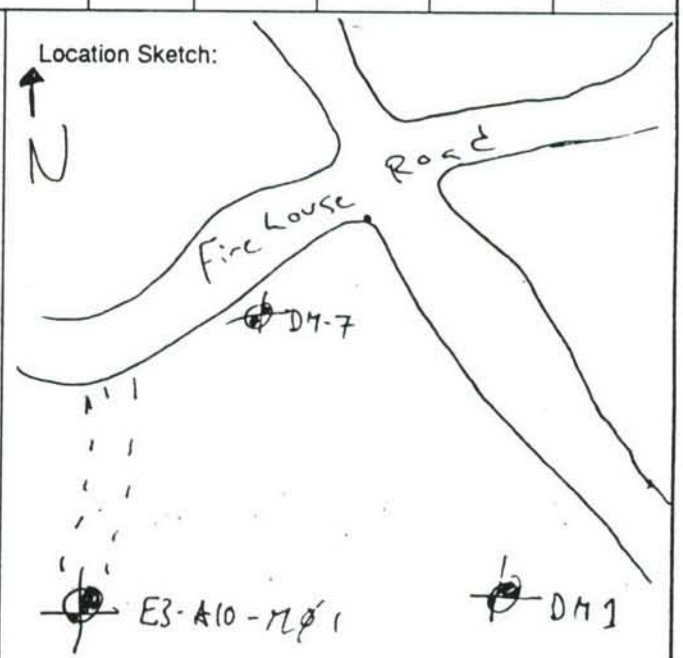
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/12/93	1347	1437	0'	19'					

Abbreviations:

Abbr.	Meaning
SS	split spoon
R	recovery
F	fine
M	medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



Page: 1 of 3 4

WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX
Well Number: E3 P36-M01
Job Number:
Today's Date: 8/5/93
Well Start/Completion Dates:
SAME AS ABOVE

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Type: Continuous Slot HORIZONTAL 1/4" SPACING
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'
Screened Interval: 8-18'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES INC.
Schedule: 40
Material: Stainless Steel
PVC X
Other

Length: 1
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Joint(s): Design THREADED
Composition PVC
Depth(s) 8.0'
Centralizer: Design
Composition N/A
Depth(s)
Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)
Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

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Sent to USATHAMA:
Date Sent:
Xerox:
Page 1 of 3
Signature:
WELL CONSTRUCTION LOG
Well Number:
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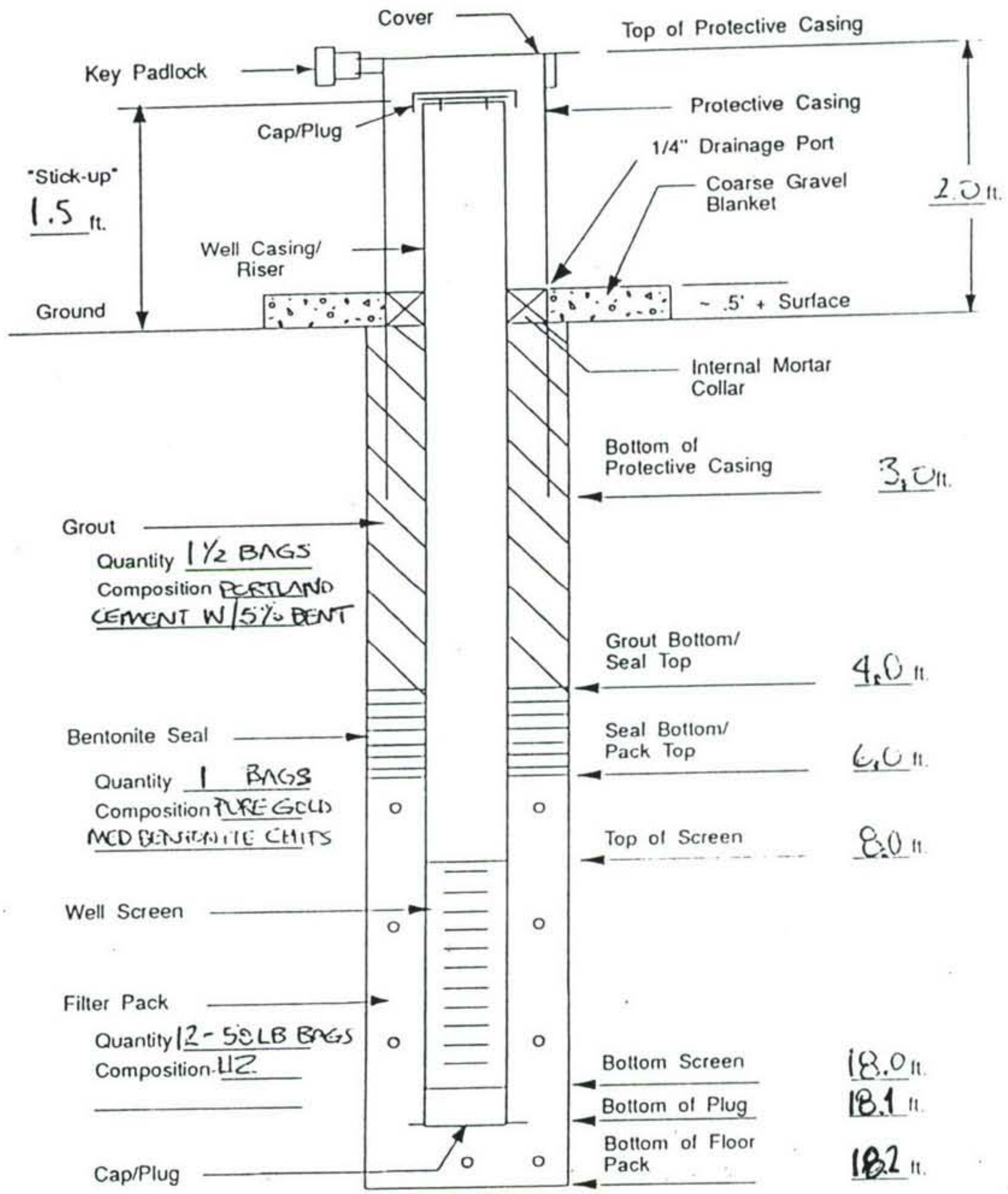
Well Construction Log: __________
Site ID Number: P36
Well Number: E3-P36-M01
Today's Date: 8/5/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: __________
Page 2 of 3
Signature: __________
Xerox: __________
Sent to USATHAMA: __________
Date Sent: __________

BORING LOG GENERAL DATA
Borehole Number: E3-P36-M01
Page: 2 of
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:
33

Project: SUDBURY ANNEX | Boring: E3 P36 M01 |

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		8/5/93 START/COMPLETE - 1415/1635 GROUND SURFACE			
		SS1 - DRY, TIGHT ~~TAN~~/~~YEL~~ TAN/ YELLOW/BROWN SILT W/SAND WEATHERED PHYLLITE @ ≈ 2' OVA = 0.0 ppm	1425 R=1.6	4 15 21 30	NOTES: 1) SPLIT SPOONS DRIVEN W/ 140LB HAMMER W/ 30" FREEFALL 2) DEPTH & R IN FEET 3) 8 1/4 HSAs 4) 2" x 2' SPLIT SPOONS
2	2				
4	4	SS2 TAN, DRY, TIGHT SILTY CLAY W/ WEATHERED ROCK FRAGMENTS & GRAVEL (SUBROUNDED) SOME FE STAINING.	1443 R=1.5	19 26 20 15	
6	6				DRILLING NOTES
9	▽	H_2O ≈ 9.0' TAN, WET TIGHT SILTY CLAY W/ WEATHERED ROCK AS ABOVE (TILL) APPROX 30% OF SPOON SHOWS FE STAINING FROM PHYLLITE	1505 R=1.0	15 26 37 73	1) AUGER THROUGH ASPHALT 2) DRIVE SPLIT SP 0-2' 3/ AUGER TO 4' 4/ DRIVE SPLIT SP 4-6' 5/ AUGER TO 9'. DIFFICULT COBBLES OR BOULDERS ENCOUNTERED
11					
14		SS4 - TAN, WET SILTY CLAY/W/ WEATHERED ROCK AS ABOVE. FE STAINING FROM WEATHERED PHYLLITES.	1525 R=1.5	20 31 30 43	6/ DRIVE SPL SP 9-11 7/ H_2O @ ≈ 9.0' 8/ AUGER TO 14' 9/ DRIVE SPLIT SPOON 14-16' 10/ AUGER TO 18'
16		TD - 18.0'			SAMPLE 9-11' BX3601X1

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3-P36-M01 Page: 4 of 4

Driller & Company: MARK THIBODEAU / ES

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/5/93 Completed: 8/5/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A-300

First Encountered: 9' Date: 8/5/93

While Drilling: 9' Date: 8/5/93

At Boring Completion: 9.0' Date: 8/5/93

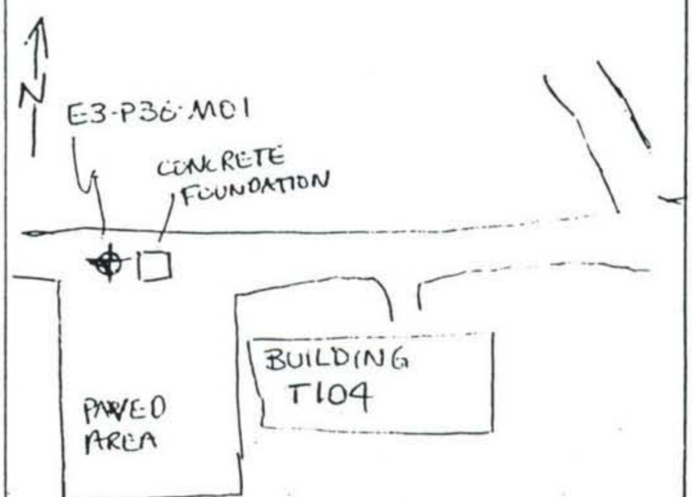
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/5/93	1415	1635	0	18'					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



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BORING LOG GENERAL DATA
Borehole Number: ____
Page: 1 of ____
Signature: ____
Xerox: ____
Sent to USATHAMA: ____
Date Sent: ____
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Page 1 of 3 Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

WELL CONSTRUCTION LOG
Well Number: ______

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WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX
Well Number: E3-P36-M02
Job Number: ______
Today's Date: 8/6/93
Well Start/Completion Dates: 8/6/93

Installation Difficulties: ______

Remarks: ______

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC
Schedule: 40
Type: Continuous Slot HORIZONTAL 1/4" SPACING
Perforated ______
Louvre ______
Other ______

Materials: Stainless Steel ______
PVC X
Other ______

Length: 10'
Screened Interval: 8-18'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Slot: Size (inches): .020 Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²

Casing

Manufacturer: BEDROCK ENTERPRISES
Schedule: 40
Material: Stainless Steel ______
PVC X
Other ______
Length: 10'
Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED
Composition PVC
Depth(s) 8.0

Centralizer: Design N/A
Composition
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s) ______

Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

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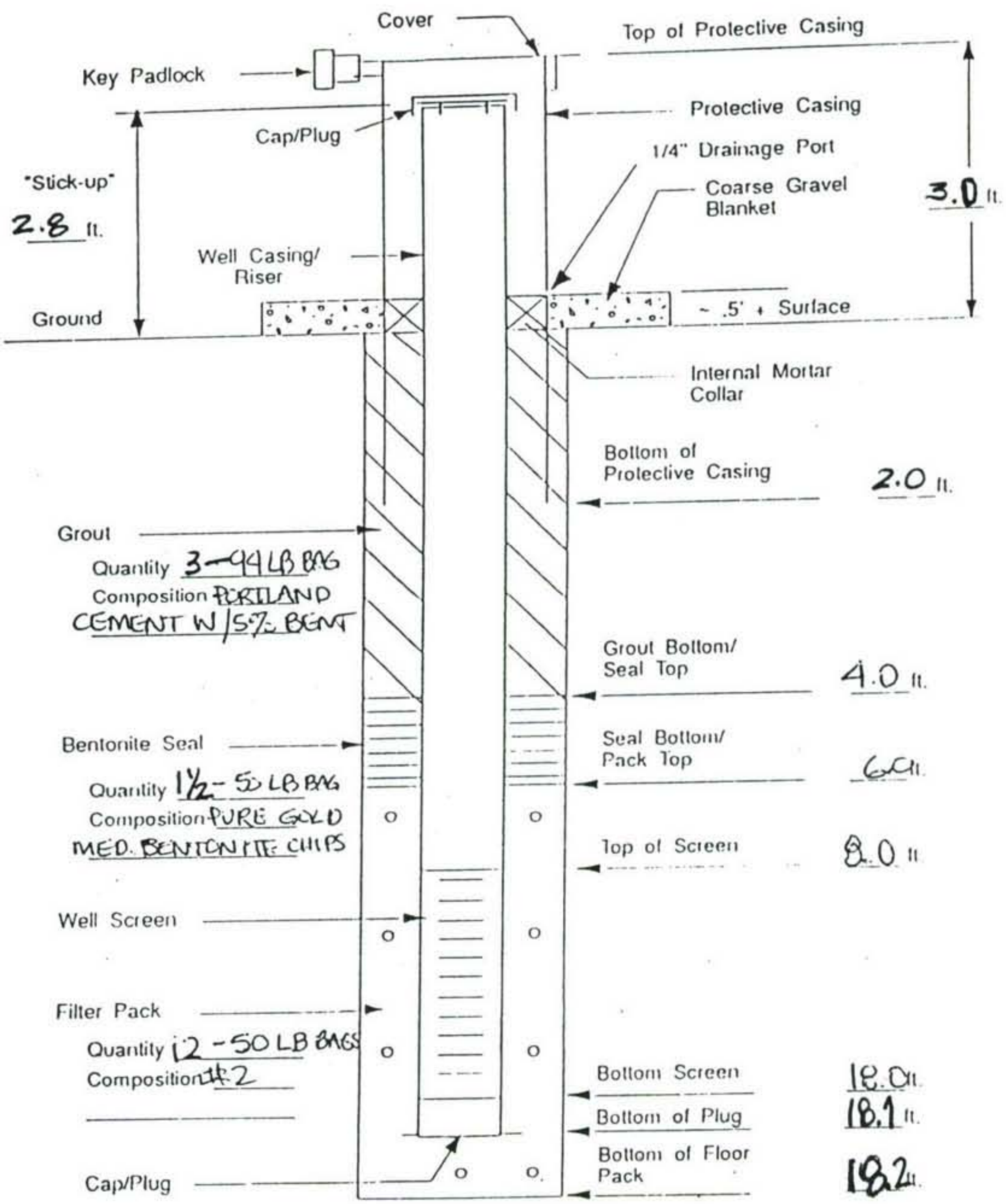
Well Construction Log:

Site ID Number: P36

Well Number: E3-P36-MO2

Today's Date: 8/6/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG

Well Number: E3 P36 MO2

Page 2 of 3

Signature: Walter Gray

Xerox:

Sent to USATHAMA:

Date Sent:

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3-P36-M02 Page: 3 of 4

Driller & Company: MARK THIBODEAU

Geologist/Logger & Company: W GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/6/93 Completed: 8/6/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A 300

First Encountered: 10' Date: 8/6/93

While Drilling: 10' Date: 8/6/93

At Boring Completion: 10' Date: 8/6/93

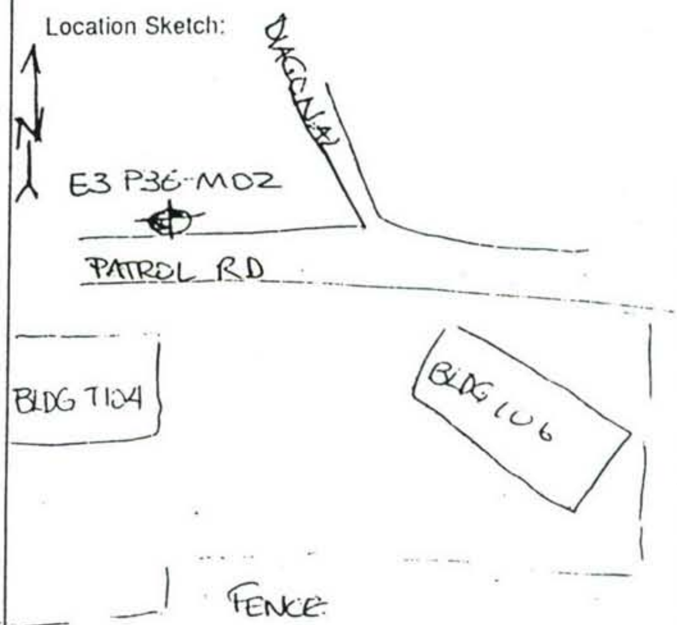
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/6	1102		0	18.0'					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______ Page: 1 of ______
Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

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BORING LOG GENERAL DATA
Borehole Number: E3-P36-M02
Page: 2 of
Signature: Walter Grey
Xerox:
Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX

Boring: E3-P36-M02

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description 8/6/93 START/FINISH - 1102/	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
		~~SS1~~ - DRY, TAN YELLOW FN-MED GRAINED SAND, LOOSE, SOME COARSE GRAINS FN/MD/CS = 30/60/10. OVA = 0.0 ppm	SS1 1103 R=1.0	7 7 9 11	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL
2					2/ DEPTH & R IN FEET
4		~~DRY~~ TAN, MOIST. MED/CS GRAINED SAND, LOOSE FN/MED/CS = 10/40/50 NO GRAVEL	SS2 1111 R=1.5	5 4 6 8	3/ 8¼" HSAs 4/ 2" X 2' SPLIT SPOONS
		OVA = 0.0 ppm			
6					DRILLING NOTES 1/ DRIVE SPL SP 0-2'
9		MOIST, TAN, TIGHT SANDY SILT W/ WEATHERED GRAVEL BECOMING WET @ 10'. SAND MED/FN GR SND/SILT 20/80. GRAVEL IS WEATHERED GRANODIORITE, QTZ/QTZITE PHYLLITE. OVA = 0.0 ppm	SS3 1127 R=.9	19 18 17 13	2/ AUGER TO 4' 3/ DRIVE SPL SP 4-6'
10	▽				4/ AUGER TO 9' - ENCOUNTERED COBBLES DRILLING SLOW 5/ DRIVE SPLIT SPOON 9-11'
11					6/ H_2O @ ≈ 10' 7/ AUGER TO 14'
14		WET GREY SANDY SILT W/ GRAVEL FN/GR SND/SILT = 20/40% GRAVEL - WEATHERED, SUBROUNDED QTZ/QTZITE, GRANODIORITE, PHYLLITE SOME FE BANDING, STAINS OVA = 0.0 ppm	SS4 1147 R=1.3	9 9 11 11	8/ DRIVE SPL SP 14-16' 9/ AUGER TO 18' (TD) 10/ INSTALL MW
16		TD = 18.0'			
19					SAMPLE 9-11 BX3602X1
21					

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Page 1 of 3 Xerox: ______ Sent to USATHAMA: ______
Signature: Water Grp Date Sent: ______

WELL CONSTRUCTION LOG
Well Number: E3-P36-MO3
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WELL CONSTRUCTION LOG

Site ID: ______
Well Number: E3-P36-MO3
Job Number: ______
Today's Date: 8/7/93
Well Start/Completion Dates: 8/7/93

Installation Difficulties: ______

Remarks: ______

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Type: Continuous Slot HORIZONTAL 1/4" SPACING
Perforated ______
Louvre ______
Other ______

Materials: Stainless Steel ______
PVC X
Other ______

Length: 10'

Screened Interval: 9-19.0'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in^2/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Material: Stainless Steel ______
PVC X
Other ______
Length: 10'
Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED
Composition PVC
Depth(s) 9.0'

Centralizer: Design NA
Composition
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)

Protective Casing: Material HARDENED STEEL
Inner Diameter 6"

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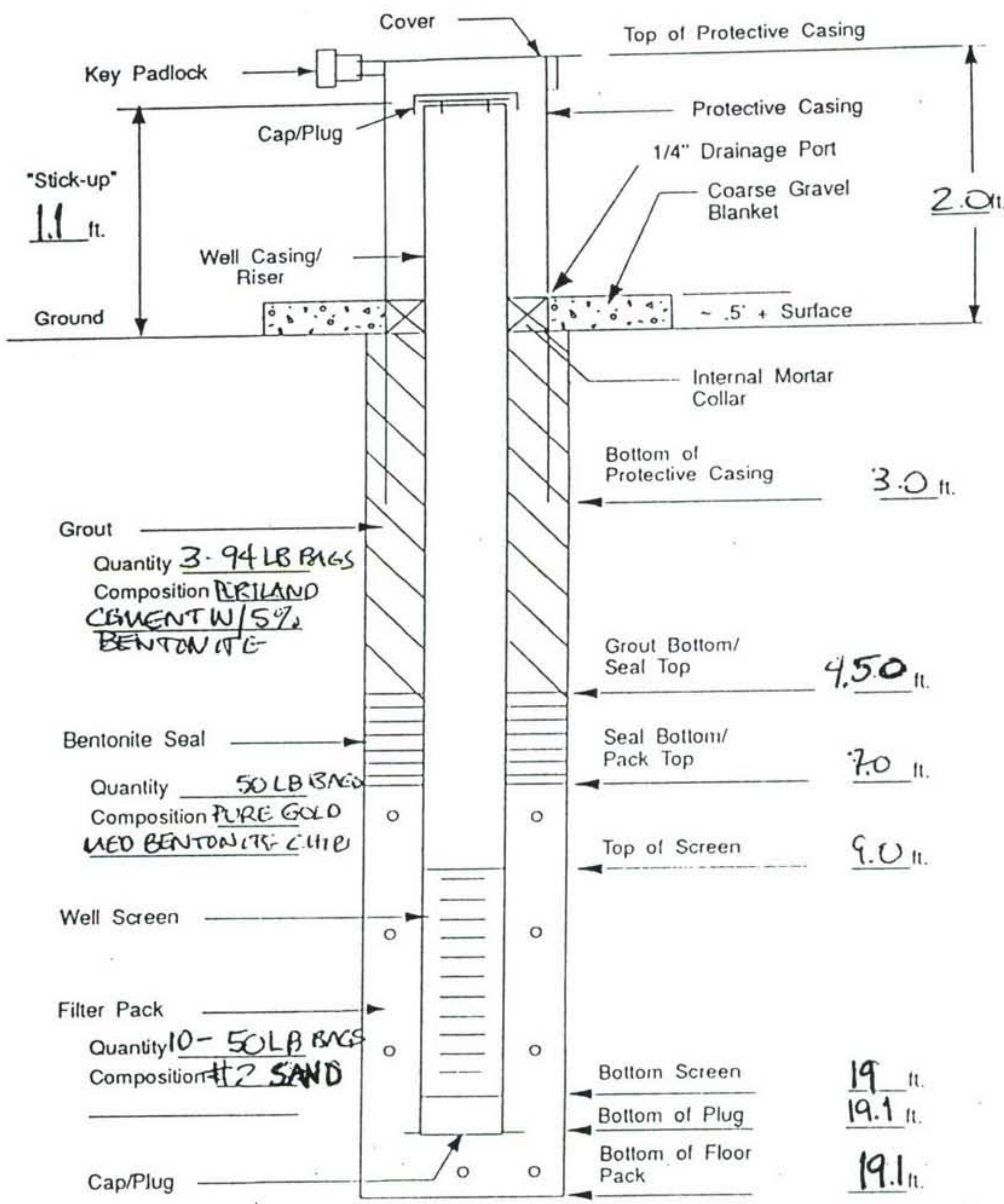
Well Construction Log:
Site ID Number: P36
Well Number: E3 P36-M03
Today's Date: 8/7/93

WELL CONSTRUCTION



Sent to USATHAMA:
Date Sent:
Xerox:
Page 2 of 3
Signature:
WELL CONSTRUCTION LOG
Well Number: E3-P36-M03
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Project: SUDBURY ANNEX

Boring: E3-P36-M03

8/7/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description START/FINISH-1002/@1250 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		SS1- DRY, LIGHT BROWN MD/CS SAND W/GRAVEL, LOOSE GRAVEL SUBROUNDED GRANODIORITE, QTZ, QZITE PHYLLITES. OVA 0.0 ppm	1001 R=.5	3 6 8 11	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL 2/ DEPTH & R IN FEET 3/ HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		4.0-4.2' MOIST, TAN, MED/CS GRAIN SAND W/GRAVEL GRADING TO GRAVELLY SAND MOIST W/FINES BECOMING MORE ABUNDANT. 5.7-6.0' TAN MOIST FN GRAINED SAND HOMOGENEOUS	SS2 1034 R=1.1	2 6 7 7	DRILLING NOTES
6					1/ DRIVE SPL SP 0-2'
9		9.0→9.3 MED/CS GR SAND W/GRAVEL MOIST 9.3-9.6 100% GREY FN GR SAND, MOIST HOMOGENEOUS 9.6→9.9 - FN/MD/CS GR. GRAVELLY SND GRAVEL WEATHERED GRANODIORITE QTZ PHYLLITES. OUTWASH 9.8→100% FN GR. SAND GREY MOIST	SS3 1045 R=1.5	4 5 7 7	2/ AUGER TO 4' 3/ DRIVE SPLSP 4-6 4/ AUGER TO 9' 5/ DR SPLIT SPOON 9-11'
11	▽	H_2O@ ≈ 13'			6/ AUGER TO 14' 7/ H_2O ≈ 13.0'
14		FN GRAINED GREY WET SAND GRADING TO CS GRAINED SAND W/MED & FINES AND GRAVEL (14.5-15.5) 15.5'+ FN GRAINED SILTY ~~SAND~~ LOG W/ CLAY, PLASTIC, GREY BROWN	SS4 1056 R=1.2	4 4 7 10	8/ DRIVE SPL. SP 14-16' 9/ AUGER TO 19' TD: 19.1'
16					SAMPLES 14-16' BX3603X1
			R=		

BO. G LOG GENERAL DATA

Borehole Number: E3-P36-M03

Page: 2 of

Sent to USATHAMA: Date Sent:

Signature: [signature]

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3-P36-M03 Page: 4 of 4

Driller & Company: DAVE / ESD

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/7/93 Completed: 8/7/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A-300

First Encountered: 13.0 Date: 8/7/93

While Drilling: 13.0 Date: 8/7/93

At Boring Completion: 13.0' Date: 8/7/93

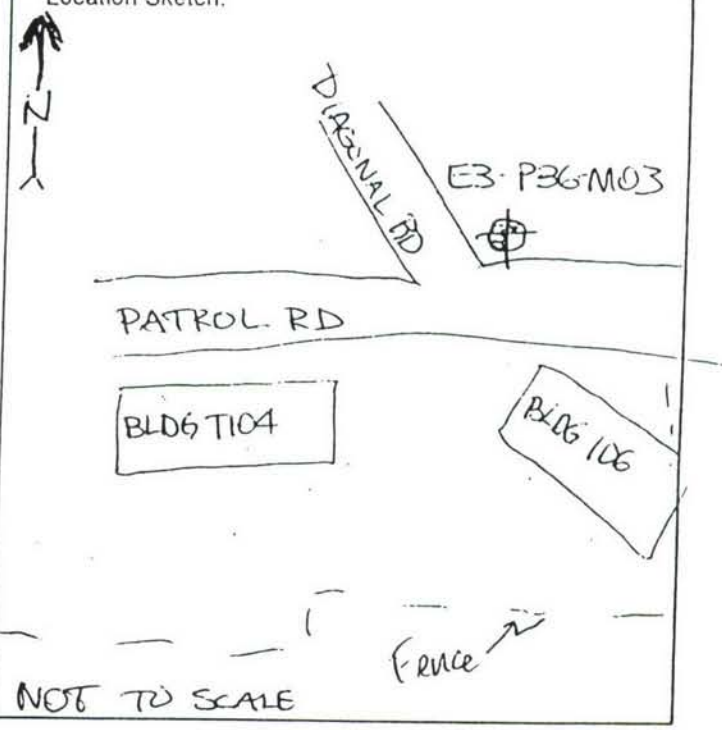
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/7/93	1002	1250	0	19.1					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



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BORING LOG GENERAL DATA
Borehole Number: ______ Page: 1 of ______
Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______
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WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX

Well Number: E3-P37-M01

Job Number:

Today's Date: 8/6/93

Well Start/Completion Dates: 8/6/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Type: Continuous Slot HORIZONTAL SLOT 1/4" SPACING

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10'

Screened Interval: 9.5 — 19.5'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED

Composition

Depth(s)

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE

Use(s)

Protective Casing: Material HARDENED STEEL

Inner Diameter 6.0"

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WELL CONSTRUCTION LOG

Well Number:

Page 1 of 3 Signature:

Xerox:

Sent to USATHAMA:

Date Sent:

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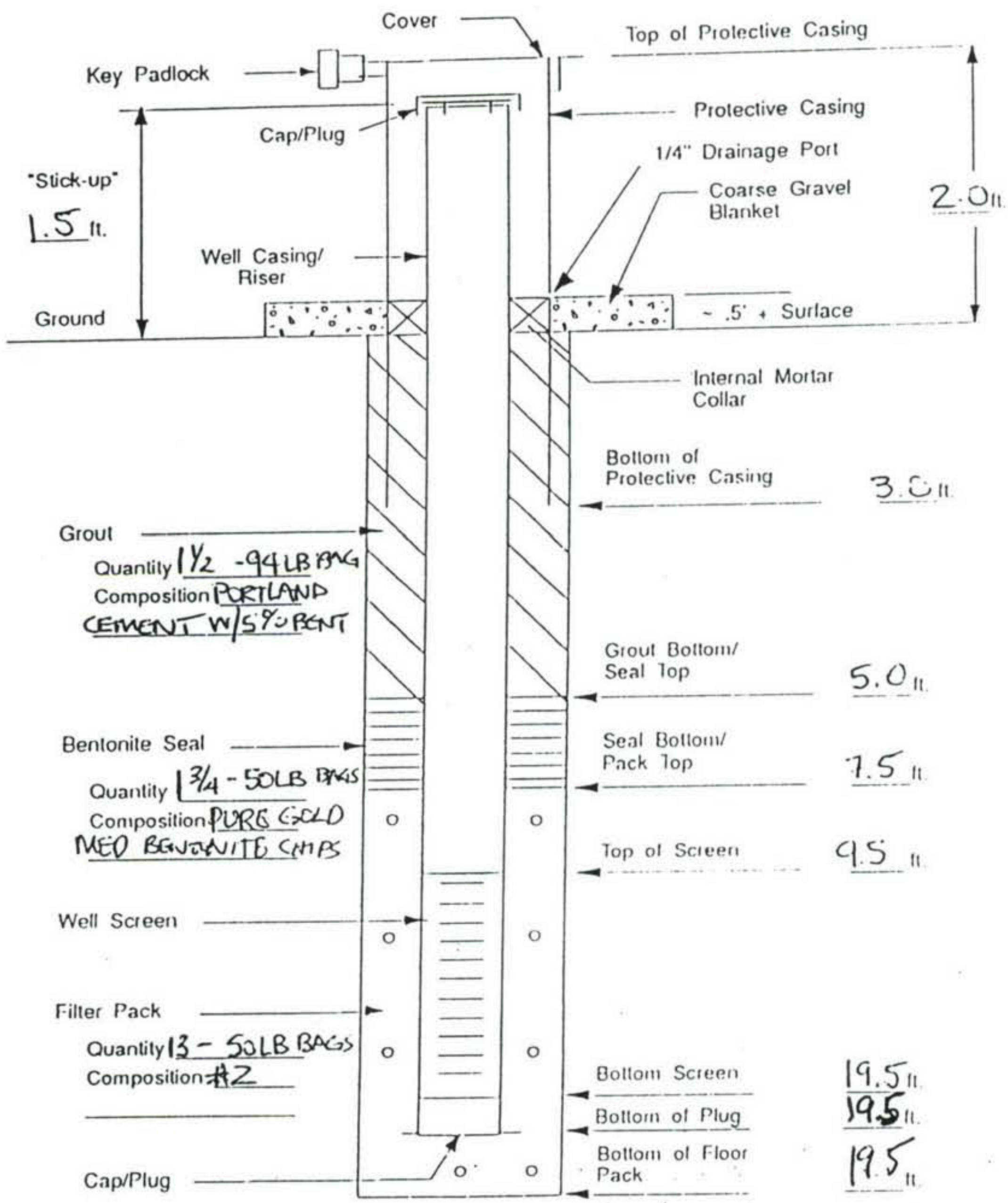
Well Construction Log:
Site ID Number: P37
Well Number: E3-P37 M01
Today's Date: 8/6/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-P36-M01

Page 2 of 3
Signature: Walter Gray
Xerox:

Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX

Boring: E3-P37-M01

Page: 3 of 4

8/6/93

START/FINISH – 0820/1025

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE		3	NOTE:
		SS1 - DRY YELLOW BR-MED/CS SAND W GRAVEL - LOOSE FN/MD/CS = 20/50/30 SND/GRAVEL 80/30. GRAVEL SUBROUNDED QTZ GRANODIORITE, PHYLLITES OVA-0.0ppm	0824 R:1.2	6 7 6	1/SPLIT SPOONS DRIVEN W/140LB HAMMER W/ 30" FREE FALL 2/DEPTH & "R" IN FEET 3/8¼" HSA 4/2"x2' SPLIT SPOON
2					
4		SS2 - TAN, MOIST, MED/CS GRAINED SAND, MINOR GRAVEL <10% FN/MD/CS = 10/40/50. GRAVEL SUBROUNDED QTZ, GRANODIORITE, PHYLLITE LOOSELY COMPACTED OVA 0.0 ppm	0833 R=1.1	3 4 6 7	DRILLING NOTES 1/DRIVE SPL SP 0-2 2/AUGER TO 4' 3/DRIVE SPLIT SP 4-6'
6					
9		SS3 9-10' SAND AS ABOVE 10-11' CS GR SAND BED W/GRAVEL FE STAINING. FINES INCREASING @11' FN/MD/CS = 10/30/60. GRAVEL SUBROUNDED QTZ, GRANODIORITE PHYLLITE, WEATHERED OVA 0.0 ppm	0844 R=1.7	3 4 11 24	4/AUGER TO 9' 5/DRIVE SPLIT SPOON 9-11' 6/AUGER TO 14' 7/ $H_2O \simeq 12.0'$ 8/DR. SPL SP 14-16 9/AUGER TO 19 10/DRIVE SPLIT SP 19-21' 11/INSTALL MW
11	▽	$H_2O \simeq 12.0'$			
14		SS4 GREY, WET, SANDY SILT W/WEATHERED GRAVEL, TIGHT SOME FE STAINS. GRAVEL ~~SUBANG~~ SUBROUNDED QTZ, GRANODIORITE, PHYLLITE, MAFICS. TILL OVA = 0.0 ppm	0905 R:1.1	18 16 17 28	
16				10 53 54	
19		SS4 19-20.5 BROWN, WET, TIGHT SILT W/MINOR SND, GRAVELS HEAVILY WEATHERED. 20.5-21' GREY, TIGHT SILTY CLAY. GRAVEL <10% WEATHERED QTZ/QTZITE, GRANODIORITE-PHYLLITE	0925 R=1.5	73	SAMPLES 14-16 BX3701X1
21		TD = 19.5'			

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Sent to USATHAMA: ____ Date Sent: ____

Xerox: ____

Page: 2 of ____ Signature: ____

BORING LOG GENERAL DATA
Borehole Number: E3-P37-M01

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ecology and environment

BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3 P37-M01 Page: 4 of 4

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/6/93 Completed: 8/6/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A-300

First Encountered: ≈12.0' Date: 8/6/93

While Drilling: ≈12.0' Date: 8/6/93

At Boring Completion: 12.0 Date: 8/6/93

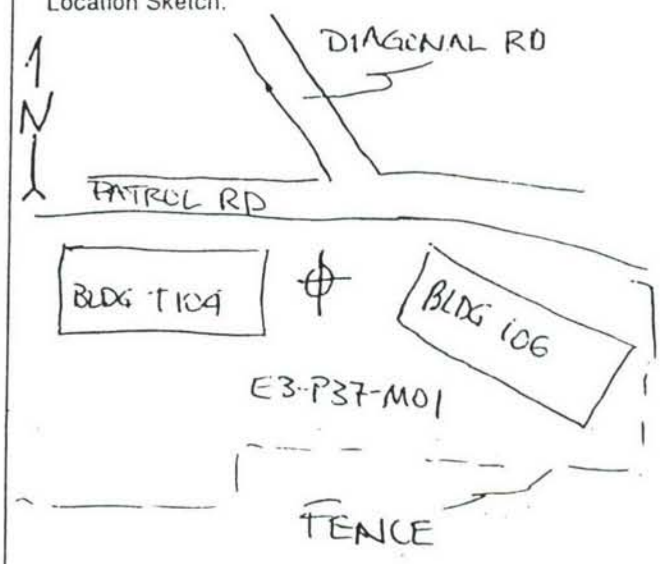
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/6	0820	1025	0	19.5'					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R=	RECOVERY

Location Sketch:



NOT TO SCALE

Boring Log General Data
Borehole Number: E3-P37-M01
Page: 1 of
Signature: Walter Graf
Xerox:
Sent to USATHAMA:
Date Sent:
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1 4

Page: 1 of 4

WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX

Well Number: E3-P37-M02

Job Number:

Today's Date: 8/7/93

Well Start/Completion Dates: 8/7/93, 8/7/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC.

Schedule: 40

Type: Continuous Slot HORIZONTAL 1/4" SPACING

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10'

Screened Interval: 9-19'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC.

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25

Joint(s): Design THREADED

Composition PVC

Depth(s) 9.0'

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE

Use(s)

Protective Casing: Material HARDENED STEEL

Inner Diameter 6.0"

Sent to USATHAMA:

Date Sent:

Page 1 of 3 Xerox:

Signature: Walter Gray

WELL CONSTRUCTION LOG

Well Number: E3-P37-M01

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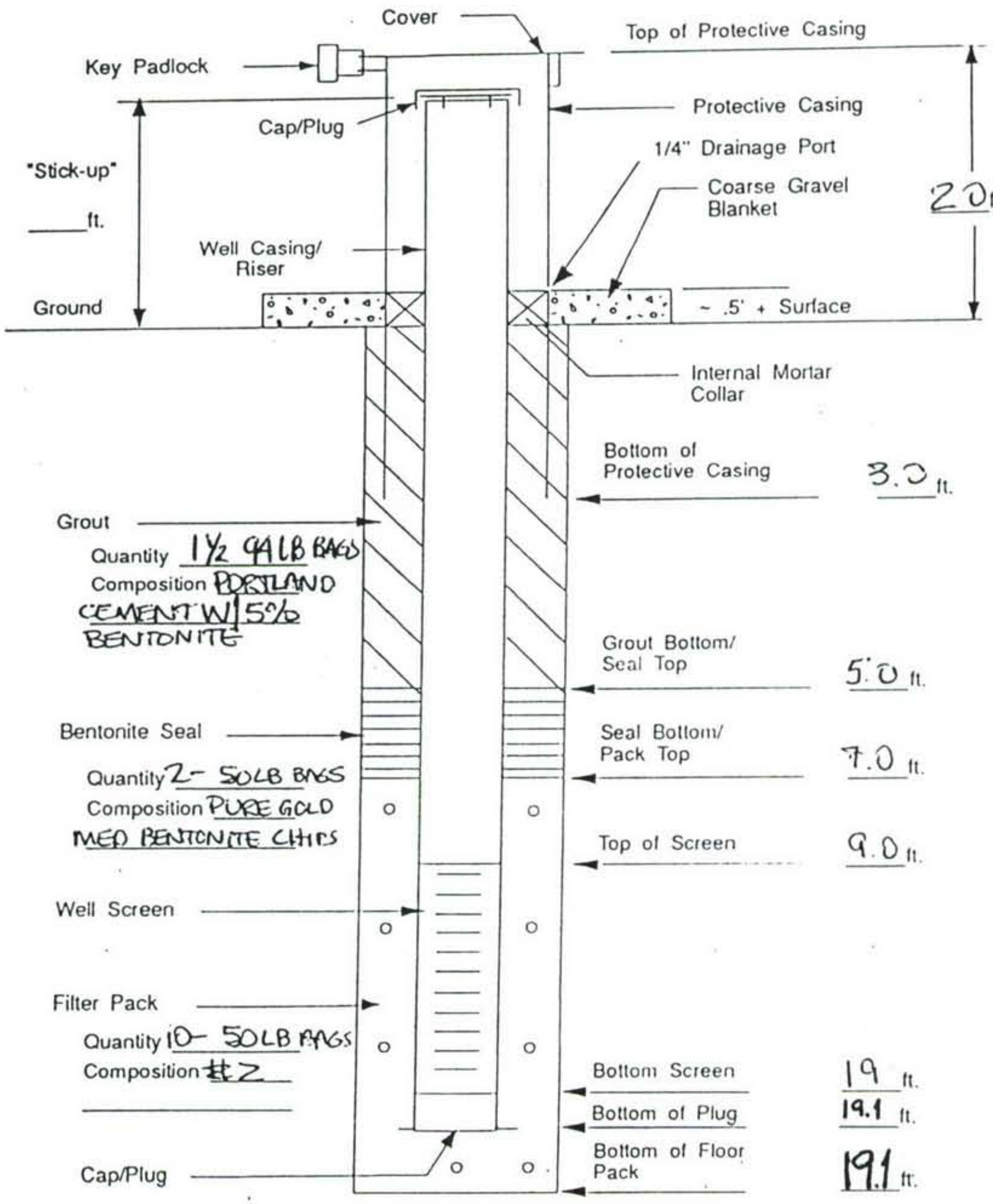
Well Construction Log: ______
Site ID Number: P37
Well Number: E3-P37-MO2
Today's Date: 8/7/93

WELL CONSTRUCTION



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Date Sent: ______
Page 2 of 3
Signature: Walter Gr[illegible]
Xerox: ______

WELL CONSTRUCTION LOG
Well Number: E3-P37-MO2

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Project: SUDBURY ANNEX

Boring: E3-P37-M02

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		8/7/93 START/FINISH - 1307/1455			
		GROUND SURFACE			
		BROWN, MOIST, GRAVELLY LOOSE SAND. FN/MED/CS = 20/40/40. GRAVEL SUBROUNDED QTZITE, GRANODIORITE, PHYLLITES. OVA - 0.0 ppm	SS1 1310 R: 1.1	4 4 5 7	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL 2/ DEPTH & R IN FEET 3/ 6 1/4" HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		4-5.5' MOIST, TAN, LOOSE MED/CS GRAINED SAND W/ WEATHERED GRAVEL OF PHYLLITE, GRANODIORITE, QTZITE, SOME FE STAINING. 5.5-6.0 FN/MED GRAINED SAND, MOIST, LOOSE, MINOR FE STAINS, NO GRAVEL FN/MED = 30/70 OVA = 0.0 ppm	SS2 1325 R: 1.2	3 5 6 6	DRILLING NOTES 1/ DRIVE SPL SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPLIT SP 4-6' 4/ AUGER TO 9' 5/ DRIVE SPLIT SP. 9-11' 6/ AUGER TO 14' 7/ DRIVE SPL SP 14-16' 8/ H_2O @ 14.0' 9/ DRIVE SPL SP 14-16 10/ AUGER TO 19' 11/ TD = 19.0'
6					
9		100% FN GRAINED SAND, GREY, MOIST, SOME FE STAINS, NO GRAVEL, LOOSE. OVA - 0.0 ppm	SS3 1340 R: 1.4	3 4 5 5	
11					
	▽	H_2O @ 14.0'			
14		14-14.5 WET, BROWN, SAND W/ GRAVEL FN/MED/CS = 30/50/20. GRAVEL SUBROUNDED. 14.5-16.0 - 100% GREY SANDY SILT W/ CLAY AT BOTTOM OF SPOON PLASTIC OVA - 0.0 ppm	SS4 1400 R: 1.7	2 2 2 3	
16		TD = 19.0'			SAMPLE 14-16'-BX3702X1
19	TD				

BORING LOG GENERAL DATA
Borehole Number: E3-P37-M02
Page: 2 of
Signature: [signature]
Sent to USATHAMA: Date Sent:

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX   Boring: E3-P37-M03   Page: ~~3~~ 4 of 4

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E   Signature: Walter Graf

Date Boring Started: 8/9/93   Completed: 8/9/93

Water Levels (from Ground Surface)   Drilling Rig:

First Encountered: 14.3'   Date: 8/9/93

While Drilling: 14.3'   Date: 8/9/93

At Boring Completion: 14.3'   Date: 8/9/93

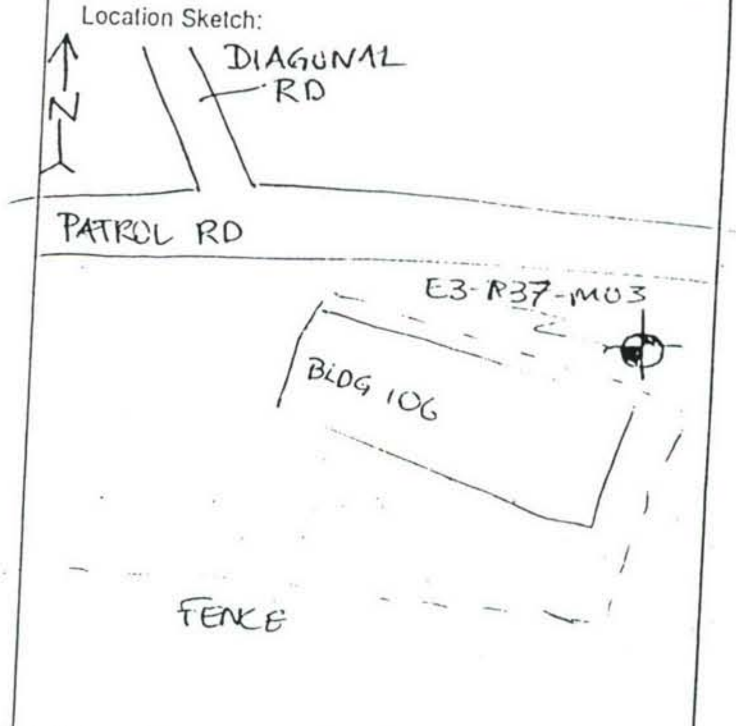
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/9/93	0917	1120	0	20					

Abbreviations:

Abbr.	Meaning
SPL' SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: E3-P37-M03
Page: 1 of
Signature: Walter Graf   Xerox
Sent to USATHAMA: Date Sent:

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WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX
Well Number: E3-P37 M03
Job Number:
Today's Date: 8/9/93
Well Start/Completion Dates: 8/8/93 , 8/9/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC
Schedule: 40
Type: Continuous Slot HORIZONTAL 1/4" SPACING
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'
Screened Interval: 10-20'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Material: Stainless Steel
PVC X
Other

Length:
Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED
Composition PVC
Depth(s) 10.0'

Centralizer: Design
Composition N/A
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)

Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

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WELL CONSTRUCTION LOG
Well Number:
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Signature:
Xerox:
Sent to USATHAMA:
Date Sent:
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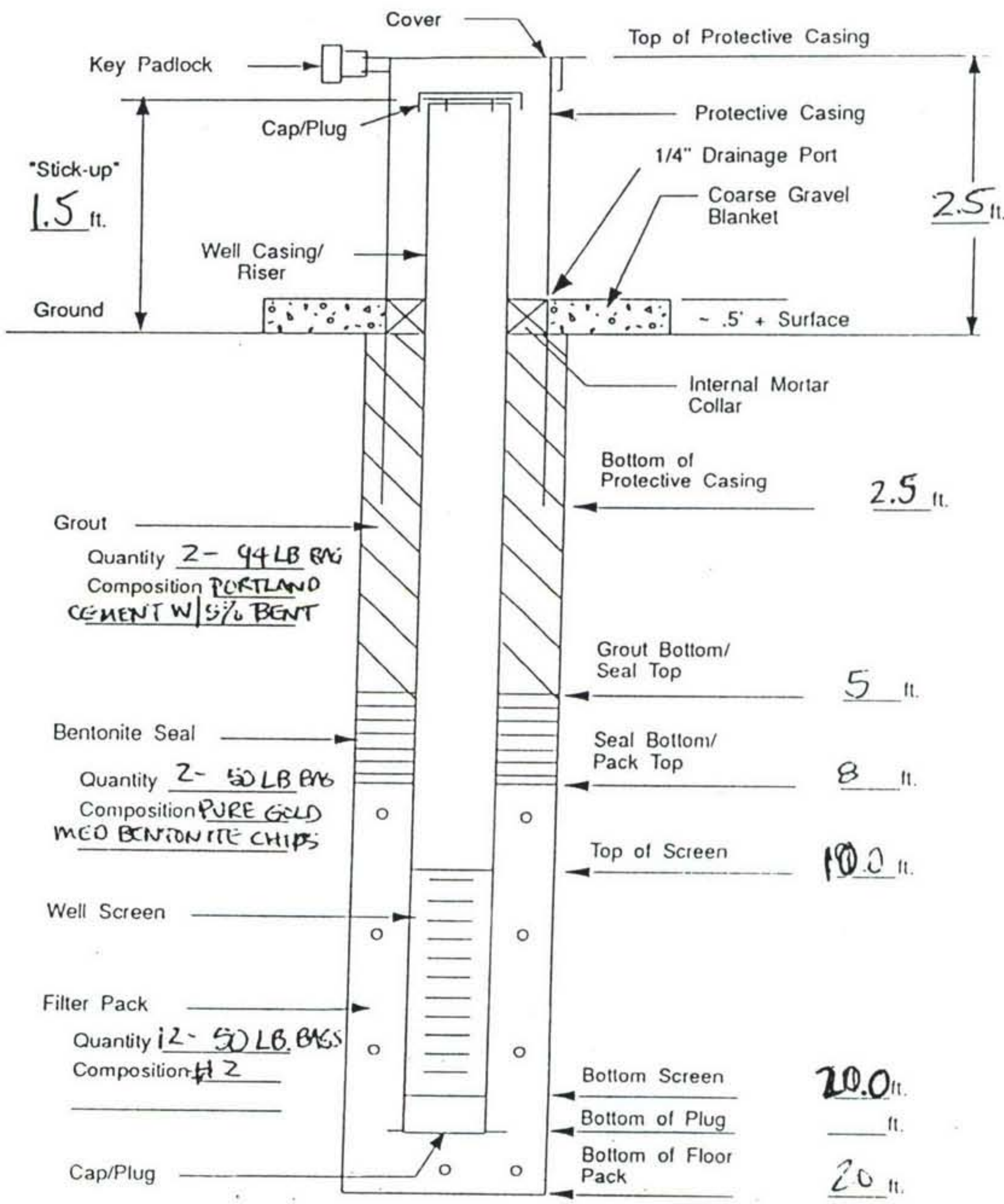
Well Construction Log:
Site ID Number: P37
Well Number: E3-P37-MO3
Today's Date: 8/9/93

WELL CONSTRUCTION



Page 2 of 3 Xerox:
Signature: Walter Gid
Sent to USATHAMA:
Date Sent:

WELL CONSTRUCTION LOG
Well Number: E3-P37-MO3

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Project: SUDBURY ANNEX

Boring: E3-P37-M03

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		START/FINISH – 0917/1120			
		GROUND SURFACE			
		FN/MD/CS GRAINED SAND W/SUBROUNDED GRAVEL OF PHYLLITE, GRANODIORITE QTZITES. FN/MD/CS = 20/50/30 TAN, MOIST. OVA = 0.0 ppm	SS1 0935 R=1.4	3 4 5 5	NOTE: 1/SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL
2					2/DEPTH & R IN FEET
4		4.–4.4 = SAND AS ABOVE 4.4–4.6 – 100% TAN, FN GR. SAND 4.6–4.8 – FN/MD GR SAND W/MINOR SUBROUNDED GRAVEL FN/MD = 30/70. 4.8–5.1 – MD/CS GR SAND W/GRAVEL, TAT BR 5.1–5.3 FN GR SAND, NO GRAVEL 5.3–6.0 – FN/MD GR SAND W/MINOR GRAVEL SUBROUNDED PHYLLITE, GRANODIORITE QTZITE FN/MD 30/70, 10% GRAVEL	SS2 0952 R=1.7	4 5 7 9	3/8¼" HSAs 4/2" X 2' SPLIT SPOONS
6					DRILLING NOTES 1/DRILL OUT ASPHALT (0–6" ASPHALT)
9		9–9.3 – FN/MD SAND, FN GR SAND, FN/MED AS ABOVE W/MINOR GRAVEL 9.3–11.0 100% FN GRAINED SAND FE STREAKS MINOR SILT, LOOSE MOIST, CROSS BEDDING EVIDENT	SS3 1005 R=1.8	4 4 6 8	2/DRIVE SPLIT SP 0–2' 3/AUGER TO 4' 4/DRIVE SPLIT SPOON 4–6 5/AUGER TO 9' 6/DRIVE SPLIT SP 9–11
11					7/AUGER TO 14'
	▽	H_2O @ ≈ 14.3'			
14		GREY-BROWN, WET, MD/CS GRAINED SAND W/FINES. NO GRAVEL FN/MD/CS = 30/40/30 (14–15') 15–16.0' – SILTY FN GR SAND W/FE STREAKS <10% MD GRAINS NO GRAVEL	SS4 1009 R=1.7	2 5 6 6	8/DRIVE SPLIT SP 14–16 9/H_2O @ ≈ 14.3' 10/AUGER TO 19 11/DRIVE SPLIT SP 19–21' 12/TD = ~~19.0~~ ~~21.0~~ 20.0 13/REMOVE HSAs AS MW IS INSTALLED
16					
19		19–20 FN/MD/CS GR SAND W/MINOR (<10%) SUBROUNDED GRAVELS OF PHYLLITES GRANODIORITE, QTZ, QTZITE, WET BROWN. 20–20.8 FN GRAINED SAND BROWN W/HEAVY FE STAINS, BECOMING SILTIER DOWN SECTION 20.8–21 WET, GREY SILT W/ CLAY. SILT/CLAY 70/30	SS5 1019 R=1.9	5 5 5 4	SAMPLES 14-16 BX3703X1
		TD = ~~21~~ 20.0'			

BORING LOG GENERAL DATA

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Project: SUDBURY ANNEX	Boring: E3-P37-M03 Page: ~~3~~ 4 of 4
Driller & Company: DAVE	
Geologist/Logger & Company: W. GRAF | E&E	Signature: Walter Graf
Date Boring Started: 8/7/93	Completed: 8/7/93
Water Levels (from Ground Surface)	Drilling Rig: INGERSOLL RAND A-300
First Encountered: 14.0	Date: 8/7
While Drilling: 14.0	Date: 8/7
At Boring Completion: 14.0	Date: 8/7

Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/7/93	~~1307~~ 0917	1120	0	~~20~~ 20					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:

BORING LOG GENERAL DATA
Borehole Number: E3-P37-M02
Page: 1 of ___ Signature: ___
Xerox: ___
Sent to USATHAMA: ___ Date Sent: ___

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WATERSHED 3

GROUNDWATER MONITORING WELL

E3-A57-M01

SUDBURY ANNEX

WELL CONSTRUCTION LOG

Page: 1 of 4

Site ID:
Well Number: E3 - P57 - M01
Job Number:
Today's Date: 8/10/93
Well Start/Completion Dates: 8/10/93 / 8/10/93

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Type: Continuous Slot HORIZONTAL 1/4" SPACING
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'

Screened Interval: 9' - 19'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Material: Stainless Steel
PVC X
Other

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED
Composition PVC
Depth(s) 9.0'

Centralizer: Design N/A
Composition
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)

Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

Sent to USATHAMA:
Date Sent:
Xerox:
Page 1 of 3
Signature:
WELL CONSTRUCTION LOG
Well Number:
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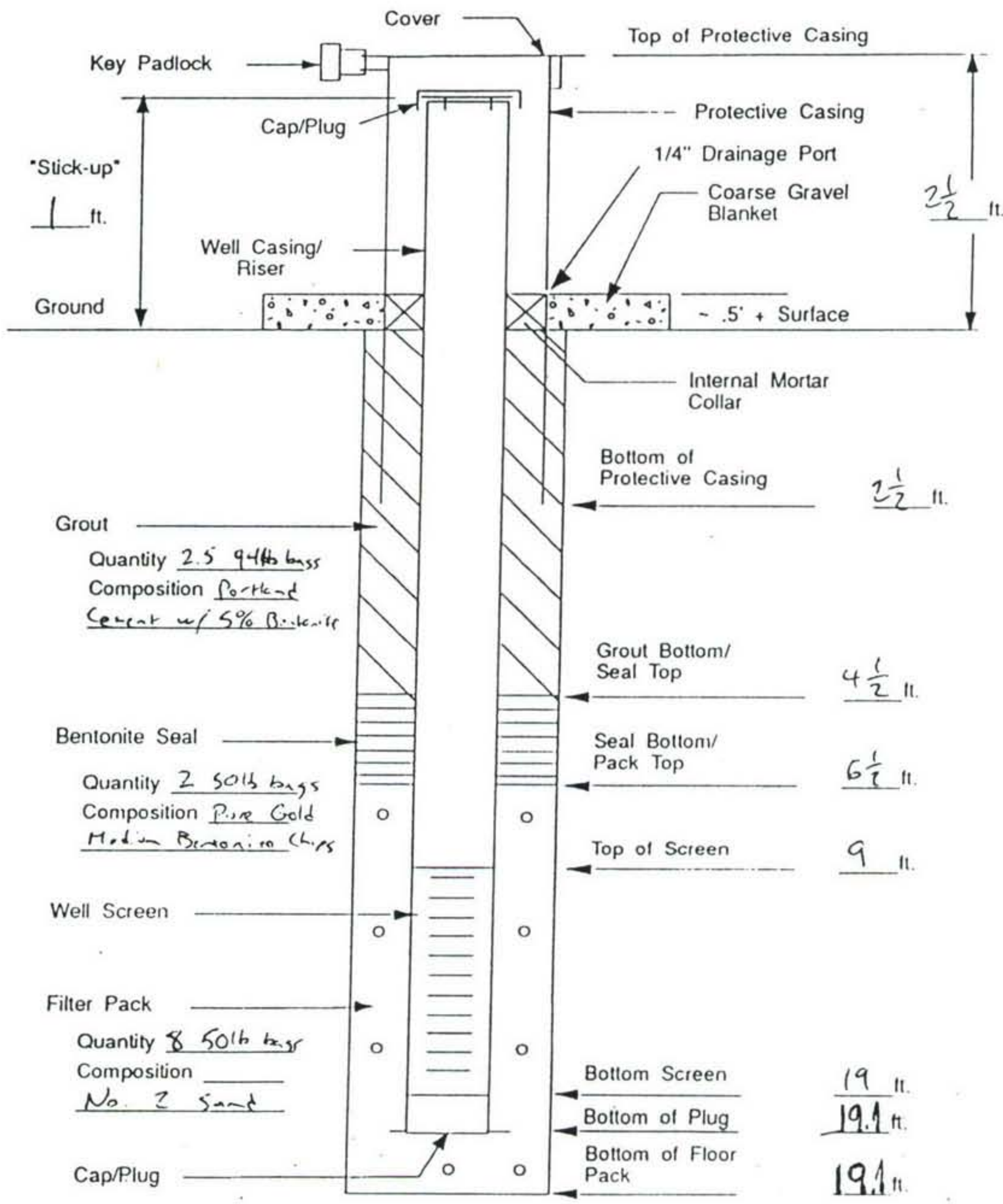
Well Construction Log: ______
Site ID Number: P57
Well Number: E3-P57-MØ1
Today's Date: 8/10/93

WELL CONSTRUCTION



Sent to USATHAMA: ______
Date Sent: ______
Xerox: ______
Page 2 of 3
Signature: ______
WELL CONSTRUCTION LOG
Well Number: ______
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Project: Sudbury Annex | Boring: E3-P57-MØ1 | Page: 3 of 4

8/10/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			Time Start: 1127 Time Stop: 1420
0		0-0.2' Sandy silt - drk brn; low moisture; 80%F, 20%M, high organic content 0.2-1.0' Silty Sand: lt yellow brn; low moisture; 65%F, 35%M; Minor organics	SS1 OVA = 0ppm	1, 1, 3, 4 1.0'R	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL 2/ DEPTH & R IN FEET 3/ 6¼ HSAs 4/ 2" X 2' SPLIT SPOONS
2		Sand as above			
4		4.0-4.1 Sand as above 4.1-5.0 Silty sand; med. brn; low moisture; 20%F, 60%M, 20%C, few very small gravels 5.0-5.3 Silty sand; lt. brn; low moisture 40%F, 60%M; iron staining throughout, no gravels	SS2 OVA = 0ppm	1, 3, 5, 6 1.3'R	
6 7.5 ▽		Sand as above - Cobbles up to 4" diam coming up in auger flights wet at 7.5			DRILLING NOTES 1) DRIVE SPL SP 0-2 2) AUGER 0-4' 3) DRIVE SPL SP 4-6' 4) AUGER TO 9' 5) DRIVE SPL SP 9-11 6) H_2O @ 7.5' 7) AUGER TO 19' 8) TD-19'
9		9.0-10.1 Silty Sand; med brn; wet; 60%M 40%C; some small gravels (~1") iron stained layer of slightly coarser grained sand at 9.5' 10.1-10.4' - Silty Sand; red brn; wet; 30%M, 70%C; 10-20% gravels up to ½" diam; iron stained throughout	SS3 OVA = 0ppm	5, 10, 23, 52 1.4'R	
11		Sand as above except 5-10% clay present at 13'			
14		Sand as above except increased clay content to ≃ 20%; plastic but not dense.			
19		TD = 19'			
					SAMPLE 9-11' BX5701X1

Sent to USATHAMA: ____ Date Sent: ____

Xerox: ____

Page: 2 of ____ Signature: ____

RING LOG GENERAL DA

Borehole Number: ____

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BORING LOG GENERAL DATA

Project: Sudbury Annex　　Boring: E3-P57-MØ1　Page: ~~1~~ 4 of 4

Driller & Company: Dave Gagne / ESD

Geologist/Logger & Company: John Pasch / E&E　　Signature: [signature]

Date Boring Started: 8/10/93　　Completed: 8/10/93

Water Levels (from Ground Surface)　　Drilling Rig: Mobile

First Encountered: 7.5'　　Date: 8/10/93

While Drilling: 7.5'　　Date: 8/10/93

At Boring Completion: 7.5'　　Date: 8/10/93

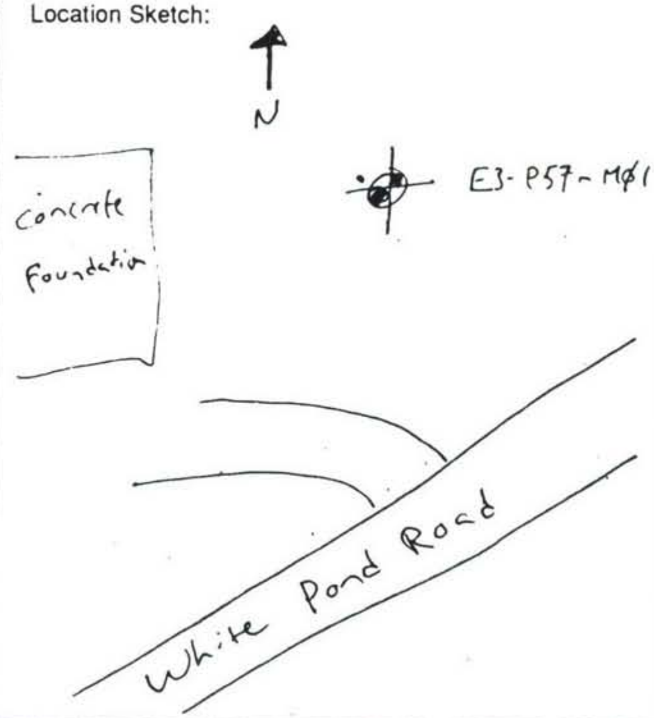
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/10	1127	1420	0'	19'					

Abbreviations:

Abbr.	Meaning
SS	split spoon
R	recovery
F	fine
M	medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______　Page: 1 of ______
Signature: ______　Xerox: ______　Sent to USATHAMA: ______　Date Sent: ______

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WATERSHED 4

GROUNDWATER MONITORING WELLS

E3-A06-M01
E3-P06-M02
E3-P22-M01

WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX

Well Number: E3-A6-~~M02~~ MØ1

Job Number: UC6066

Today's Date: 8/6/93

Well Start/Completion Dates: 8/5/93 / 8/6/93

Installation Difficulties: Very rough augering through tight fill

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: Bedrock Enterprises Inc.

Schedule: 40

Type: Continuous Slot Horizontal Slot, 0.25" spacing

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10 ft

Screened Interval: 9.0' - 19.0'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Slot: Size (inches): 0.020 Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/Ft

Casing

Manufacturer: Bedrock Enterprises Inc.

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Joint(s): Design Threaded

Composition PVC

Depth(s) 9.0'

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer N/A

Use(s)

Protective Casing: Material Steel

Inner Diameter 6"

WELL CONSTRUCTION LOG
Well Number: E3-A6-M07

Page 1 of 3
Signature:

Xerox:

Sent to USATHAMA:
Date Sent:

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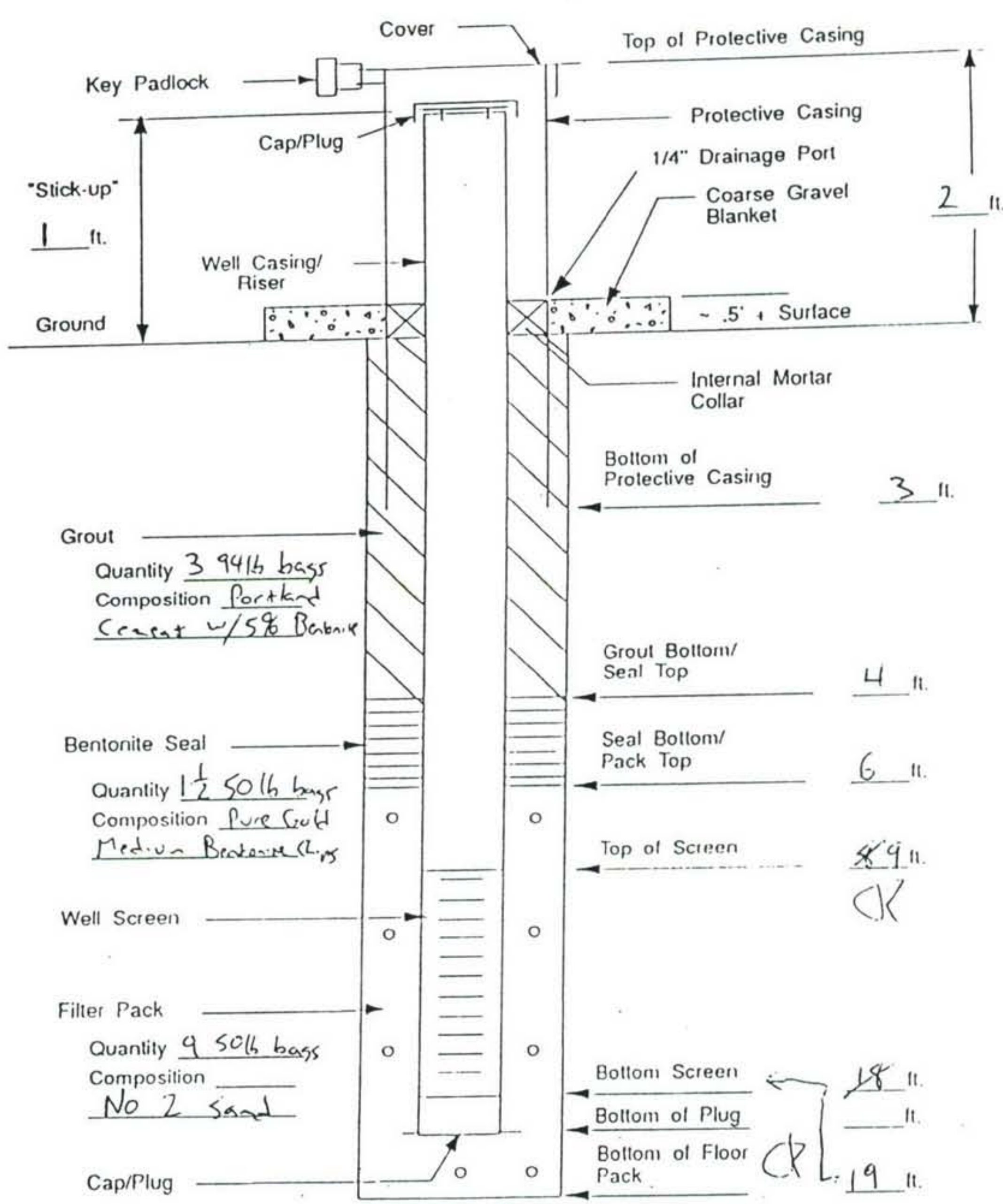
Well Construction Log:

Site ID Number:

Well Number: E3 - AG- ~~M02~~ MØ1 CR

Today's Date: 8/6/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-AG-M02

Page 2 of 3 Xerox:
Signature:

Sent to USATHAMA:
Date Sent:

Sent to USATHAMA: ______ Date Sent: ______

Xerox: ______

Page: 2 of ______ Signature: ______

BORING LOG GENERAL DATA
Borehole Number: E3-A6-MO2

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Project: SUDBURY ANNEX

Boring: E3-A6-~~M02~~ MP1 OR

Page: ~~2~~ 3 of ~~3~~ 4

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
					Time Start · ~~8/5~~ 1550 · 8/6 0900 Time Stop · 1635 · 1030
GROUND SURFACE					
0		0-0.2' - Silty Sand, low moisture, drk brn; 40% F, 60% M; high organics; some subangular gravels up to ½" diam 0.2-1.0' - Silty Sand, low moisture, med brn 40% F, 60% M minor organics; 10-20% subangular gravels up to ½" diam	SS1 OVA = 0 ppm	6, 18, 22, 23 1.0'R	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL.
2		Sand as above except large gravels and cobbles from 3-4'	OVA = 20 ppm downhole 1 ppm w/ charcoal filter		2) DEPTH AND RECOVERY IN FEET.
4		Silty Sand - med. brn; low moisture; 40% F 60% M; low organics; <10% silt very few gravels	SS2 OVA = 0 ppm	3, 3, 4, 13 1.2'R	3) 6¼ INCH DIA. HOLLOW STEM AUGERS 4) 2 INCH X 2 FEET SPLIT SPOONS.
6		Sand as above			DRILLING NOTES
9		9.0-10.0' Silty Sand - lt. brn; moist; 30% F 60% M, 10% C; <10% silt; few small gravels 10.0-10.4' Clayey Sand - lt. brn; moist; 60% F 40% M; low plasticity	SS3 OVA = 0 ppm	9, 9, 15, 9 1.4'R	1) DRIVE SPL SP 0-2' 2) AUGER TO 4' 3) DRIVE SPL SP 4-6' 4) AUGER TO 9'
11		Sand as above			5) DRIVE SPL SP 9-11' 6) AUGER TO 14' 7) DRIVE SPL SP 14-16' 8) H_2O @ 14'
13.5 14 ▽		13.5-14.0' Silty Sand - med. brn; moist; 20% F, 50% M, 30% C; minor clay; 10-20% gravels up to ¼" diam 14.0-14.5' Silty Sand - med. brn; wet; 40% M, 60% C; 10-20% gravels up to ½" diam; iron staining throughout	SS4 OVA: 0 ppm	67, 18 22, 32 1.0'R	9) AUGER TO 19' 10) DRIVE SPL SP 19-21' 11) TD - 19'
15.5		Silty Sand - grey brn; 40% F, 60% M; 10-20% silt; some gravels up to 2" diam; increased clay w/ depth			
19		19.0-19.8 Clayey Sand - med. brn; wet; 40% M, 60% C; 15-25% clay; some small gravels 19.8-20.0 Clayey Sand as above except decreased clay content and 60% M, 40% C 20.0-20.3 Silty Clay - med brn; wet; mostly fine; low plasticity; dense; some small gravels	SS5 OVA = 0.5 ppm	10, 22, 23, 37 1.3'R	1.5 ppm on OVA down hole 0.5 ppm with carbon filter
21		TD = 19.0'			SAMPLES 19-21 BX0601X1

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ecology and environment

BORING LOG GENERAL DATA
Borehole Number:
Page: 1 of
Signature:
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BORING LOG GENERAL DATA

Project: Sudbury Annex   Boring: E3-A6-~~MØ2~~ MØ1   Page: ~~1~~ of 4

Driller & Company: Dave Gagne / ESD

Geologist/Logger & Company: John R. Pasch/E&E   Signature: [signature]

Date Boring Started: 8/5/93   Completed: 8/6/93

Water Levels (from Ground Surface)   Drilling Rig: Mobile

First Encountered: 14'   Date: 8/5/93

While Drilling: 14'   Date: 8/5/93

At Boring Completion: 14'   Date: 8/6/93

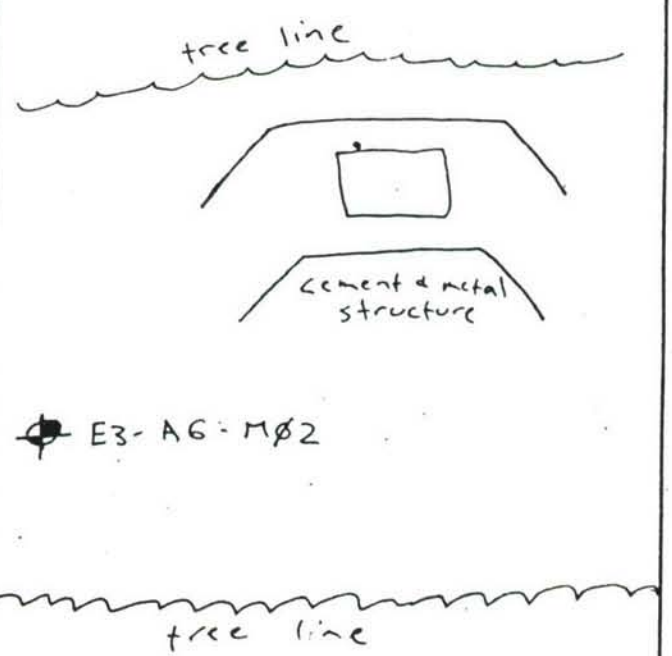
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/5	1350	1635	0'	14'					
8/6	0800	0911	14'	21'					

Abbreviations:

Abbr.	Meaning
SS	split spoon
R	recovery
F	fine
M	medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



WELL BORING ABANDONMENT LOG

Site ID: E3 - A6 - MØ2

Well /Boring Number: ______

Job Number: ______

Date: 8/16/93

1. Location with respect to replacement well/boring (if any): 50' East of E3-A6-MØ1

2. Original Well/Boring:

Water/mud level prior to grouting:	Date: ______ Level: ______
Open depth prior to grouting:	
Depth to which grout pipe was placed:	19'
Total quantity of grout used during initial grouting:	6 - 94 lb bags Portland cement w/ 5% Bentonite
Daily quantities of grout used to compensate for settlement:	

3. Casing left in hole: Depth: / Composition: / Size: N/A

Remaining casing above ground surface: Stick-up: / Composition: / Size: N/A

4. Items left in hole: Depth: / Description: / Composition: N/A

5. Total drilling depth of original hole: 19.0'

6. Sampling depths within original hole: 0-2', 3.5-5.5', 9-11', 14-16', 19-21'

7. Attach a copy of the Boring Log.

8. Attach a copy of the Construction Diagram. N/A BoreHole

Abandoned By: [signature] Date: 8/16/93

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WELL BORING ABANDONMENT LOG Page: 1 of 1 Xerox ______ Sent to USATHAMA: ______

Well Number: ______ Signature: ______ Date Sent: ______

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BOREHOLE NO. ______

ABANDONED WELL

BORING LOG GENERAL DATA	Borehole Number: E3-A6-M01	Page: 2 of	Signature:	Sent to USATHAMA:	Date Sent:	Xerox:

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Project: SUDBURY ANNEX

Boring: E3-A6-~~M01~~ M02

Page: ~~1~~ 2 of ~~2~~ 3

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			Time Start: 1052 Time Stop
0 – 2		0-0.2 Silty Sand; drk brn; low moisture 40%F, 60%M; high organics; some gravels up to 1/4" diam 0.2-0.8 Silty Sand; med brn; low moisture; 40%F, 60%M; some organics; some gravels up to 1/4" diam	SS1 OVA= 0ppm	6, 8, 10, 4 0.8'R	1) SPLIT SPOONS ARE DRIVEN WITH 140 POUND HAMMER AT 30 INCH FREE-FALL. 2) DEPTH AND RECOVERY IN FEET. 3) 6¼ INCH DIA. HOLLOW STEM AUGERS 4) 2 INCH X 2 FEET SPLIT SPOONS.
2 – 3.5		Sand as above except cobbles increasing in size to 1" diam			
3.5 – 5.5		3.5-3.7 Silty Sand, drk brn, low moisture; 10%F 60%M, 30%C; some organics; gravels up to 1/2" diam 3.7-5.0 Silty Sand; med brn; low moisture; 30%F 50%M; 20%C; some small gravels	SS2 OVA= 5ppm	3, 17, 32, 43 1.5'R	
5.5 – 9		Sand as above - large cobbles coming up in augers (8-10" diam)			
9 – 11		9-9.1 Clayey Sand; med brn; moist; 40%F, 60%M; 15-25% Clay 9.1-10.0 Sandy Clay, med brn; moist; 5-10% sand; sandy lamination at 9.7'	SS3 OVA= 0ppm	22, 18, 4, 19 1.0'R	

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Project: Sudbury Annex			Boring: E3-AG-~~M01~~ M02		Page: ~~2~~ 3 of ~~2~~ 3
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
14		DK GREY TIGHT CLAY W/ WEATHERED ZONE OF PHYLLITE ~~@~~ 15.5'. GRANODIORITE WEATHERED AT ~~15.8~~ 15.8' CONTINUED DENSE CLAY TO 16'.	534 $\boxed{1625}$ R=1.6	8 10 13 17	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL 2/ DEPTH & R IN FEET 3/ 6 1/4 HSAs 4/ 2" X 2' SPLIT SPOONS
16					
19		DK GREY CLAY AS ABOVE	$\boxed{1634}$ R=1.2	9 13 15 15	1/ AUGER TO 14' 2/ DR. SPL SP 14-16 3/ AUGER TO 19' 4/ DR SPL SP 19-21'
21					

BORING LOG GENERAL DATA M01 ~~M02~~
Borehole Number: E3-AG-~~M02~~
Page: 2 of
Signature:
Sent to USATHAMA:
Y: X:
Date Sent:
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WELL CONSTRUCTION LOG

Page: 1 of 3

Site ID: SUDBURY ANNEX
Well Number: E3-P22-M01
Job Number:
Today's Date: 8/3/93
Well Start/Completion Dates: 8/3/93 / 8/3/93

Installation Difficulties: RUNNING SILT AT BOTTOM, CAVING OF HOLE AT THE TOP

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES INC
Schedule: 40
Type: Continuous Slot HORIZONTAL
Perforated
Louvre
Other

Materials: Stainless Steel X
PVC
Other

Length: 10'
Screened Interval: 8-18'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES INC
Schedule: 40
Material: Stainless Steel X
PVC
Other
Length: 10'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Joint(s): Design THREADED
Composition PVC
Depth(s) 8.0'
Centralizer: Design N/A
Composition
Depth(s)
Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)
Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

Sent to USATHAMA: ______
Date Sent: ______

Page 1 of 3 Xerox:
Signature: Walter Sml

WELL CONSTRUCTION LOG
Well Number: E3-P22-M01

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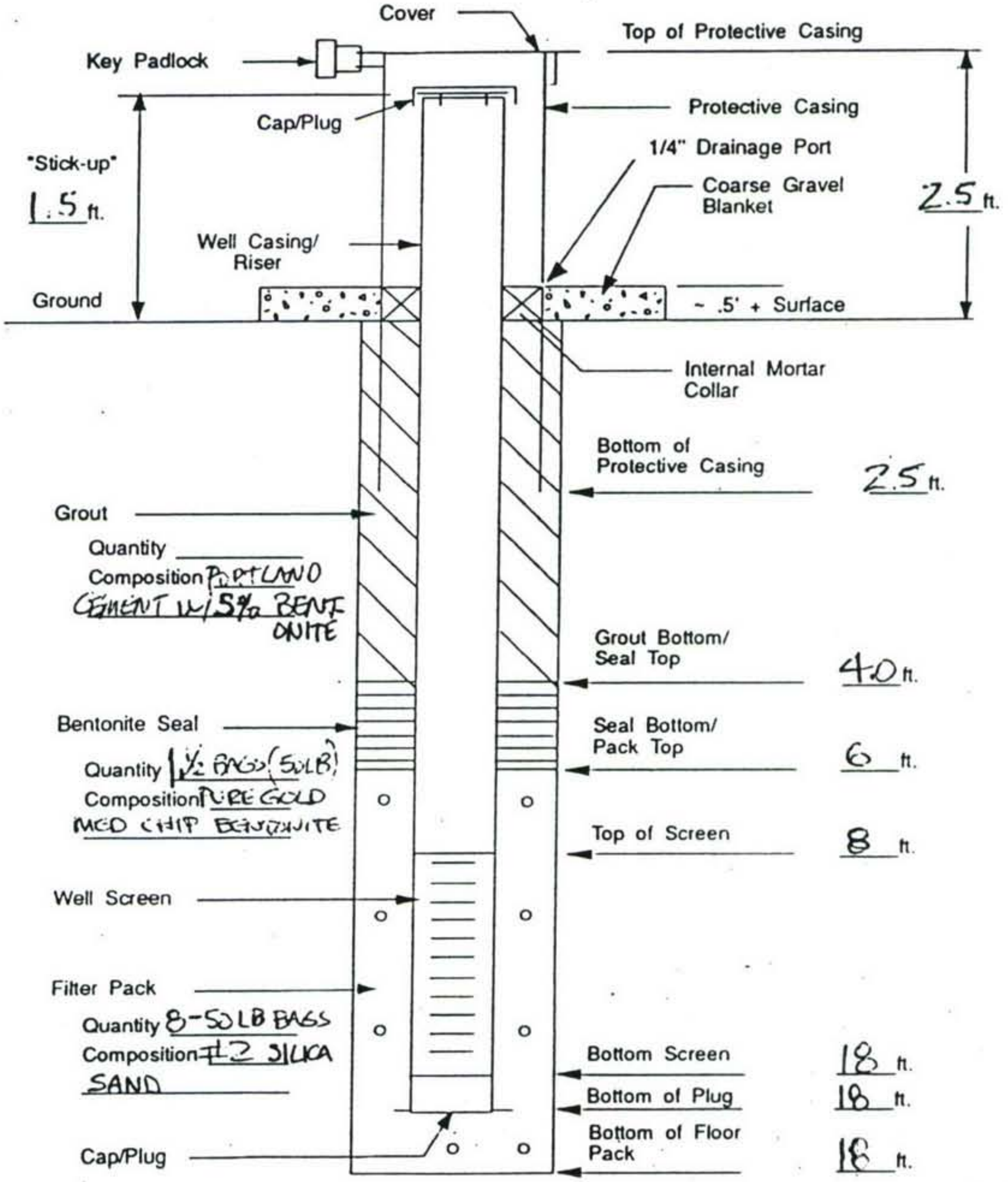
Well Construction Log:
Site ID Number: P22
Well Number: E3-P22-MC1
Today's Date: 8/3/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-P22-MC1
49
Page 2 of 3
Signature: [illegible]
Xerox:
Sent to USATHAMA:
Date Sent:

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BORING LOG GENERAL DATA
Borehole Number: E3-P22-MO1

Page: 2 of
Signature: Walter Grimm
Xerox:
Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX			Boring: E3-P22-MO1		Page: 3 of 4
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/3/93 Soil/Rock Description START/FINISH - 1413/1550 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
0–2		SS1 TAN CS GRAINED SAND W/ GRAVEL DRY LOOSE, GRAVEL <10% - QTZ, GRANODIORITE, PHYLLITE	1415 R-1.3'	2 4 3 4	NOTES: 1/ SPLIT SPOONS DRIVEN W/ 140LB HAMMER W/ 30" FREEFALL 2/ DEPTH & "R" IN FEET 3/ 6 1/4 HSA 4/ 2"x2' SPLIT SPOONS
4–6	▽	SS2 100% GREY/TAN FN GRAINED SILTY SAND ~~WE~~ VERY MOIST TO WET HOMOGENEOUS $H_2O \simeq 5'$	1420 R=1.3	4 5 7 7	DRILLING NOTES 1/ DRIVE SPL SP 0-2 2/ AUGER TO 4'
9–11		SS3 FN GRAINED SAND AS ABOVE EXCEPT NARROW BAND OF ROUNDED STONES AT ≃ 10.5'. GRAVEL ROUNDED PHYLLITE	1430 R-1.3	1 2 2 3	3/ DRIVE SPL SP 4-6' 4/ H_2O @ 5' 5/ AUGER TO 9' 6/ DRIVE SPL SP 9-11' 7/ AUGER TO 14'
14–16		SS4 TAN FN GRAINED SAND AS ABOVE OCCASIONAL GRAVEL SIZED PARTICLES DISPERSED EVENLY	1445 R=1.9	2 2 3 4	8/ DRIVE SPL SP 14'-16' 9/ AUGER TO 18' 10/ INSTALL SCREENS CASING
18		TD 18'			SAMPLE 9-11 BX2201X1

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3-P22 MW Page: 4 of 4

Driller & Company: MARK THIBODEAU / ES

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/3/93 Completed: 8/3/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A-300

First Encountered: 5' Date: 8/3/93

While Drilling: 5' Date: 8/3/93

At Boring Completion: 5' Date: 8/3/93

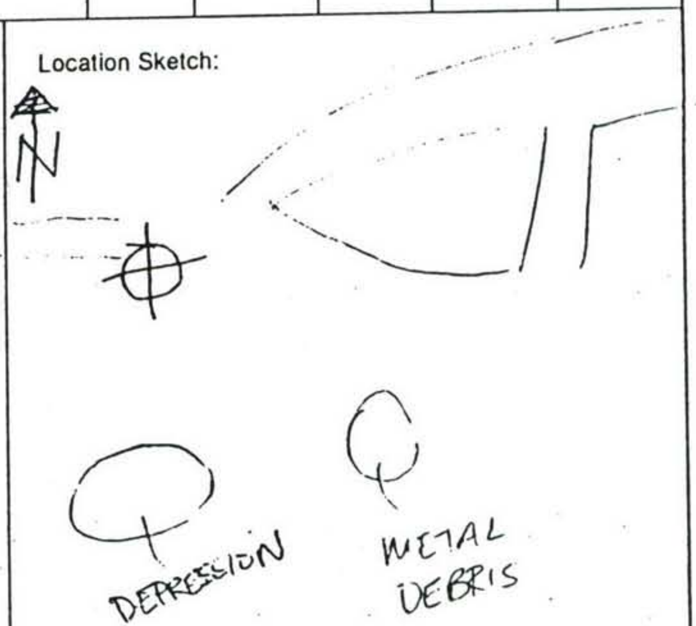
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/3	1413	1550	0'	18'					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
TD	TOTAL DEPTH
R	RECOVERY
▽	WATER LEVEL

Location Sketch:



WATERSHED 5

GROUNDWATER MONITORING WELLS

E3-A05-M01
E3-P31-M01
E3-P58-M01
E3-P58-M02

WELL CONSTRUCTION LOG

Page: 1 of ~~4~~ 5

Site ID: SUDBURY ANNEX
Well Number: E3-AS-M01
Job Number:
Today's Date: 8/10/93
Well Start/Completion Dates: 8/10/93 / 8/10/93

Installation Difficulties: RUNNING SILT - 75 GALLONS OF WATER ADDED TO WELL

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Type: Continuous Slot HORIZONTAL
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'

Screened Interval: 40-50'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Material: Stainless Steel
PVC X
Other
Length:
Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED
Composition PVC
Depth(s) 40, 30, 20, 10

Centralizer: Design N/A
Composition
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)

Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

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Date Sent:
Page 1 of 3 Xerox:
Signature: Walter Gray

WELL CONSTRUCTION LOG
Well Number: E3-AS-M01
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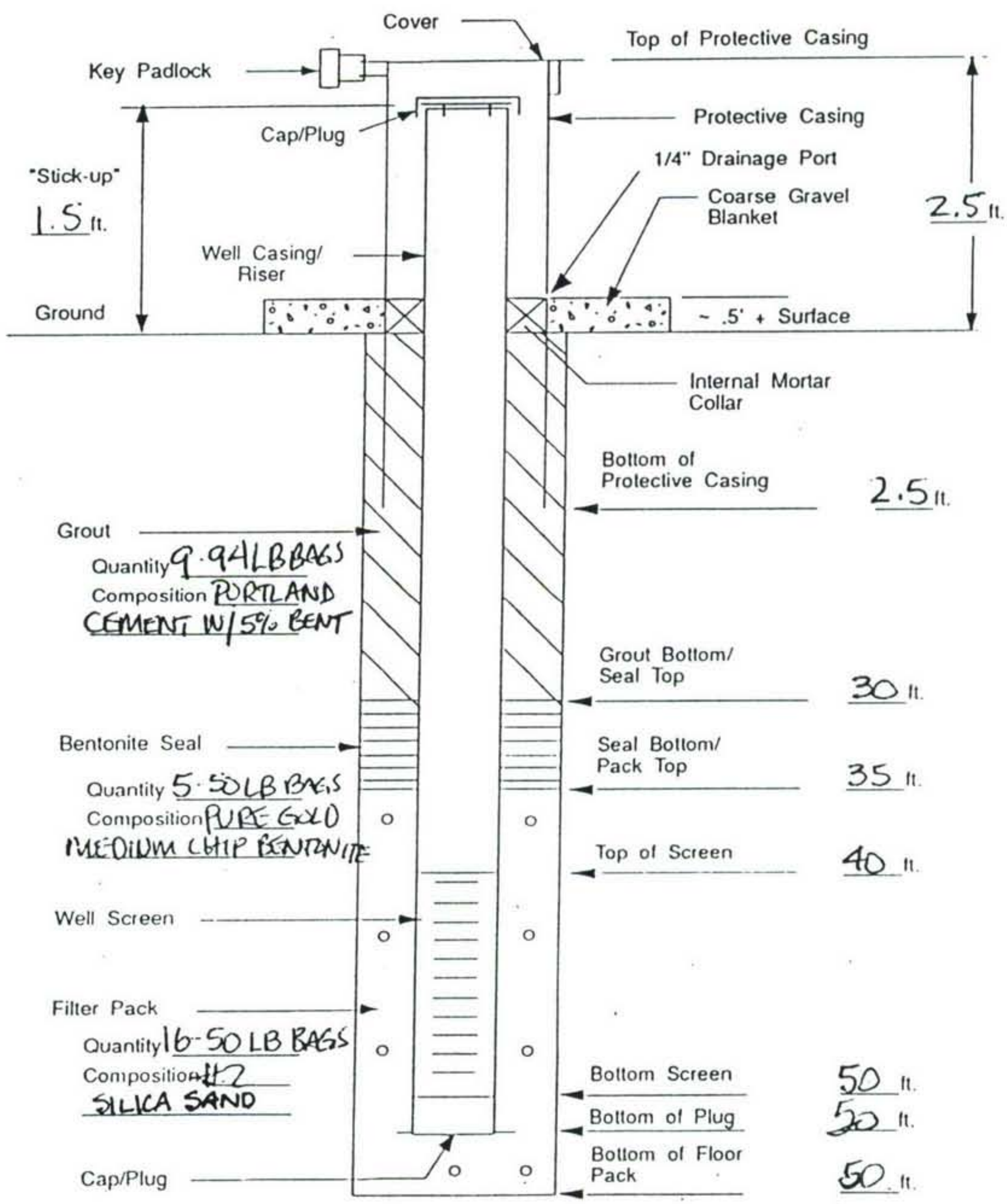
Well Construction Log:
Site ID Number: A-5
Well Number: E3-A5-M01
Today's Date: 8/10/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-A5-M01
Page 2 of 3
Signature: [signature]
Xerox:
Sent to USATHAMA:
Date Sent:
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LOG GENERAL DATA

Borehole Number: E3-A5-M01

Page: 1 of

Signature: Walter Gray

Sent to USATHAMA:

Date Sent:

Project: SUDBURY ANNEX

Boring: E3-A5-M01

Page: 3 of 5

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (8/10/93; START/FINISH – 0812/1513)	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
0–2		0-.2' = BROWN, SANDY SILT W/ROOTS .2-2 – LT BROWN, MOIST SANDY SILT W/GRAVEL; SUBROUNDED QTZITE PHYLLITE, GRANODIORITE – FN/MD/CS = 60/30/10 GRADE TO MD/CS SAND AT 1.9' OVA-0.0 PPM	SS1 0812 R=1.5	4 7 7 7
4–6		LOOSE 4-5 TAN CS GR SAND W/GRAVEL CS/MD/FN = 70/20/10. GRAVEL SUBROUNDED PHYLLITE, GRANODIORITE QTZITE 5-6' – TAN, MOIST LOOSE CS-MD GR SAND W/GRAVEL CS/MD/FN 40/50/10 GRAVEL SUBANGULAR. OVA-0.0 PPM	SS2 0820 R=1.4	6 8 8 8
9–11	▽	H_2O = 9.0' LT BROWN MD GR SAND W/CS & FINES WET LOOSE. FN/MD/CS = 30/50/20. OVA = 0.0 ppm	SS3 0833 R=1.4	3 4 4 4
14–16		14-15 – WET, TAN, FN/MD GR SND W/SOME SUBROUNDED GRAVELS HEAVY FE STAINING FROM 14.6-15.0 BUT NO GRAVEL, LOOSE 15-16 – TAN/GREY CLAYEY SILT PLASTIC, HOMOGENEOUS OVA = 0.0 PPM	SS4 0842 R=1.9	7 9 8 12
19–21		100% TAN-GREY CLAYEY SILT AS ABOVE OVA = 0.0 ppm	SS5 0853	10 11 10 10

Drilling Data

NOTE:
1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREE FALL
2/ DEPTH & R IN FEET
3/ 8 1/4 HSAs
4/ 2" X 2' SPLIT SPOONS

Drilling Notes
1/ Drive spl. sp 0-2'
2/ AUGER TO 4'
3/ DRIVE SPLIT SP 4-6'
4/ AUGER TO 9'
5/ DRIVE SPLIT SP 9-11'
6/ H_2O @ 9.0'
7/ AUGER TO 14'
8/ DRIVE SPLIT SP 14-16
9/ AUGER TO 19'
10/ DRIVE SPLIT SP 19-21
11/ AUGER TO 24', 1.0 ppm OVA @ open hole

SAMPLE
44-46' BX0501X1

Project: SUDBURY ANNEX

Boring: E3-A5-MO1

8/10/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
24		100% CLAYEY SILT AS ABOVE 25.8' - FE BANDS THEN GREY PLASTIC, SILTY CLAY	SS6 0915 R=1.3	10 18 17 18	NOTE: 1/ SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL
26		OVA = 0.0 ppm			2/ DEPTH & R IN FEET 3/ 8¼" HSAs 4/ 2" X 2' SPLIT SPOONS
29		GREY, PLASTIC, SILTY CLAY MORE SILT THAN ABOVE HOMOGENEOUS	SS7 0941 R=~~1.2~~ 1.4'	8 9 11 13	
31		OVA = 0.0 ppm			DRILLING NOTES (CONT FROM PG 1):
34		GREY, PLASTIC, CLAYEY SILT ~~&~~ HOMOGENEOUS, AS ABOVE	SS8 1010 R=1.2	15 16 12 12	12/ DRIVE SPLIT SP 24-26' 13/ AUGER TO 29' 14/ DRIVE SPL SP 29-31' 15/ AUGER TO 34 - WATER FLOWING TO SURFACE @ ≈ 30'
36		OVA = 0.0 PPM			16/ DR SPL SP 34-36' 17/ AUGER TO 39'
39		VERY WET, GREY SILT W/CLAY ~~NOT COH~~ VERY SOFT, NOT VERY COHESIVE	SS9 1037 R=1.5	0 ? 0 0 0	18/ DRIVE SPL SP 39-41' SPOON ADVANCED BY WEIGHT OF HAMMER 19/ AUGER TO 44'
41					20/ DR SPLIT SP 44-46' WEIGHT OF HAMMER DROVE SPOON 21/ AUGER TO 49'
44		100% SAME AS ABOVE GREY SILT W/MINOR CLAY	1105 R=1.4	0 0 0 0	22/ DRIVE SPL SP 49-51' WEIGHT OF SPOON
46					23/ TD = 50' 24/ INSTALL SCREEN & CASING
49		100% GREY SILT W/MINOR CLAY AS ABOVE	1138	0 0 0 0	25/ ADDED 75 GALLONS H_2O TO FORCE OUT SILT.
51					

BOR LOG GENERAL DATA
Borehole Number: E3-A5-MO1
Page: 2 of
Signature: Walter Grey XE
Sent to USATHAMA:
Date Sent:

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3-A5-M01 Page: 5 of 5

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/10/93 Completed: 8/10/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A-300

First Encountered: 9.0' Date: 8/10/93

While Drilling: 9.0' Date: 8/10/93

At Boring Completion: 9.0 Date: 8/10/93

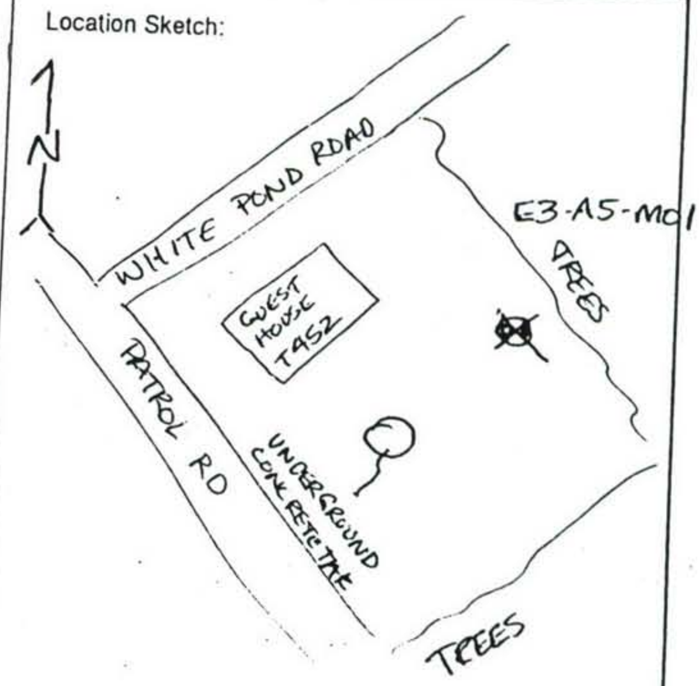
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/10	0812	~~8~~ 1513	0	50					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: Page: 1 of Signature: Xerox: Sent to USATHAMA: Date Sent:

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SUDBURY ANNEX

WELL CONSTRUCTION LOG	Page: 1 of ~~3~~ 4
Site ID: SUDBURY ANNEX	Installation Difficulties:
Well Number: E3-P31-M01	
Job Number:	
Today's Date: 8/12/93	Remarks:
Well Start/Completion Dates: 8/12/93, 8/12/93	

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC.

Schedule: 40

Type: Continuous Slot HORIZONTAL 1/4" SPACING

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10

Screened Interval: 8-18

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020 Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED

Composition PVC

Depth(s) 8.0'

Centralizer: Design

Composition N/A

Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE

Use(s)

Protective Casing: Material HARDENED STEEL

Inner Diameter 6.0"

Page 1 of 3 Xerox: Sent to USATHAMA:

Signature: Date Sent:

WELL CONSTRUCTION LOG

Well Number:

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WELL CONSTRUCTION LOG
Well Number: ______
Page 2 of 3 Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

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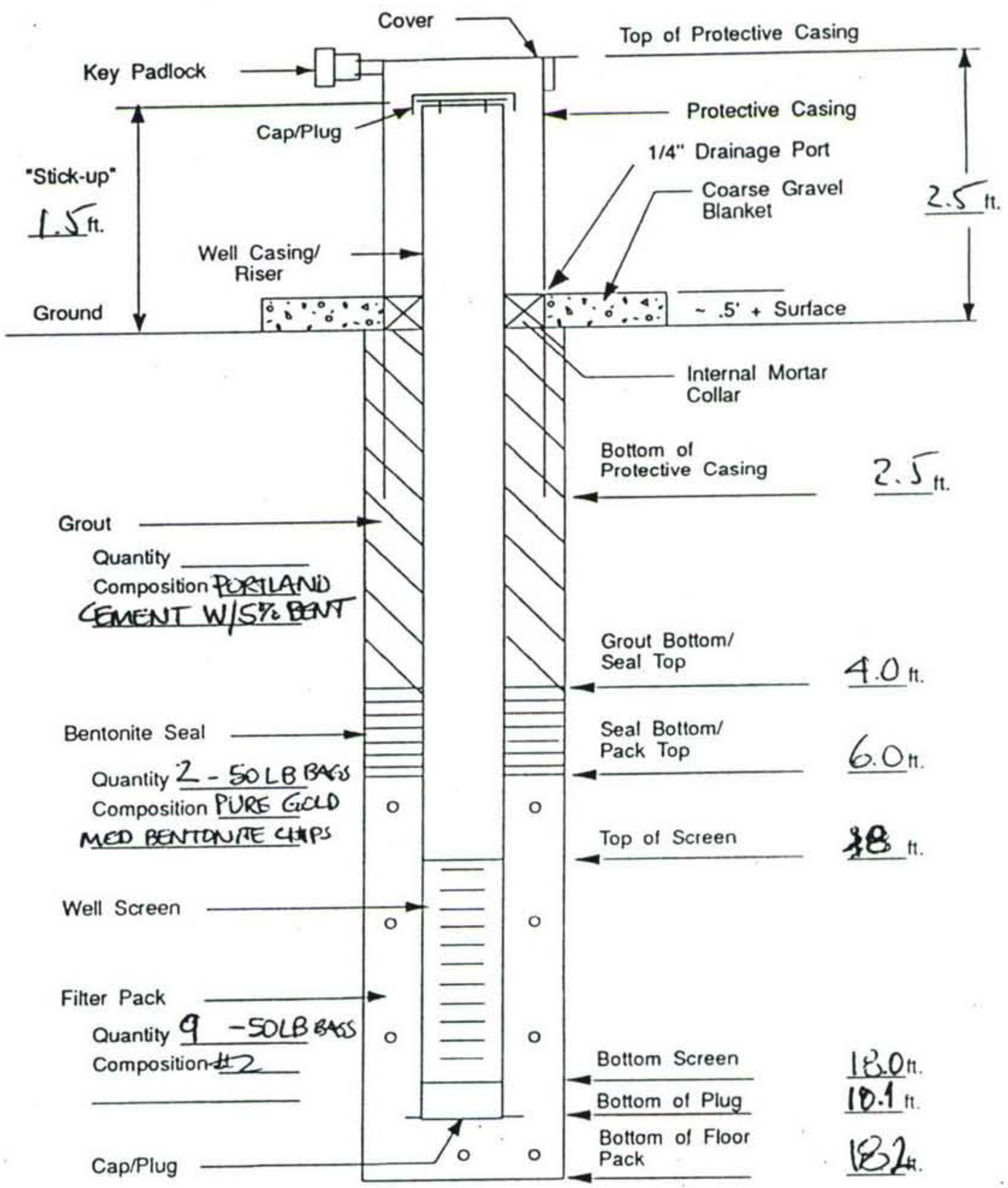
Well Construction Log: ______
Site ID Number: P31
Well Number: E3-P31-M01
Today's Date: 8/12/93

WELL CONSTRUCTION



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Project: SUDBURY ANNEX

Boring: E3 P31-MC1

8/12/93

START/FINISH-1550-1715

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
		LT BROWN, DRY, SILTY SAND LOOSE	SS1 [1550] R=.2	1 2 1 2	NOTES: 1/ SPLIT SPOONS DRIVEN W/140 LB HAMMER W/A 30" FREE FALL. 2/ DEPTH & "R" IN FEET 3/ 8¼" HSAs 4/ 2"X2' SPLIT SPOONS
2					
4		DRY, LOOSE, BROWN FN GRAINED SAND W/MINOR GRAVEL SUBROUNDED PHYLLITES, GRANODIORITE QTZITES.	SS2 [1612] R=.2	5 3 2 2	DRILLING NOTES 1/ DRIVE SPLSP 0-2' 2/ AUGER to 4' 3/ DRIVE SPLIT SP 4-6' 4/ AUGER TO 9' 5/ H_2O ≈ 7' 6/ DRIVE SPL SP 9-11' 7/ AUGER TO 14' 8/ DRIVE SPL SP 14-16' 9/ AUGER TO 18' 10/ INSTALL WELL SCREEN 8-18'
6	▽	H_2O ≈ 7' GREY			
9		9-9.5 WET, LOOSE, FN GRAINED AND COARSER FROM 9.5->11 FMT 9.5-11 FN/MD/CS SAND W/GRAVEL FN/MD/CS = 50/40/10 GRAVEL SUBROUNDED PHYLLITE, GRANODIORITE, QTZITES GREY-BROWN OVA = 6.0 PPM	SS3 [1625] R=1.6'	5 6 6 6	
11					
14		GREY, WET, LOOSE, VERY FN GRAINED SAND, CLEAN OVA = 3 PPM	SS4 [1637]	3 6 6 6	
16					SAMPLE 9-11' BX3101X1

BORING LOG GENERAL DATA
Borehole Number: E3 P31-MO1
Page: 2 of ____
Signature: ____
Sent to USATHAMA: ____
Date Sent: ____
Xerox: ____

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX   Boring: E3 P31-M01   Page: 4 of 4

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E   Signature: Walter Graf

Date Boring Started: 8/12/93   Completed: 8/12/93

Water Levels (from Ground Surface)   Drilling Rig: INGERSOLL RAND A-300

First Encountered: 7.0   Date: 8/12/93

While Drilling: 7.0   Date: 8/12/93

At Boring Completion: 7.0   Date: 8/12/93

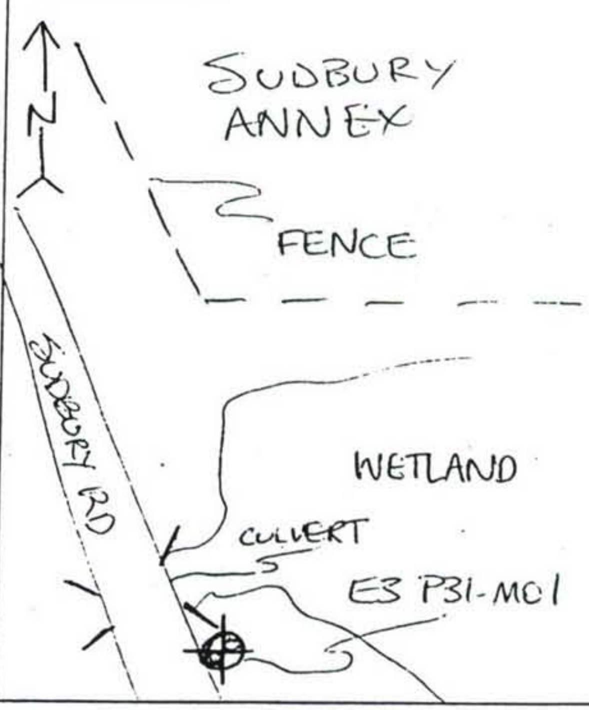
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/12/93	1550	1715	0	18					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA   Page: 1 of ____   Sent to USATHAMA: ____   Xerox: ____
Borehole Number: ____   Signature: ____   Date Sent: ____
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SUDBURY ANNEX

WELL CONSTRUCTION LOG

Site ID:

Well Number: E3-P58-MO1

Job Number:

Today's Date: 8/12/93

Well Start/Completion Dates: 8/12/93 / 8/12/93

Installation Difficulties: RUNNING SAND

Remarks: ADDED ≈100 GALLONS OF WATER TO MOVE SAND OUT OF AUGERS

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Type: Continuous Slot HORIZONTAL 1/4" SPACING

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10'

Screened Interval: 39'-49'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC

Schedule: 40

Material: Stainless Steel

PVC X

Other

Length:

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED

Composition PVC

Depth(s) 39', 29', 19', 9'

Centralizer: Design N/A

Composition

Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE

Use(s)

Protective Casing: Material HARDENED STEEL

Inner Diameter 6.0"

Sent to USATHAMA:
Date Sent:

Page 1 of 3 Xerox:
Signature: Walter Gray

WELL CONSTRUCTION LOG
Well Number: E3-P58-MO1

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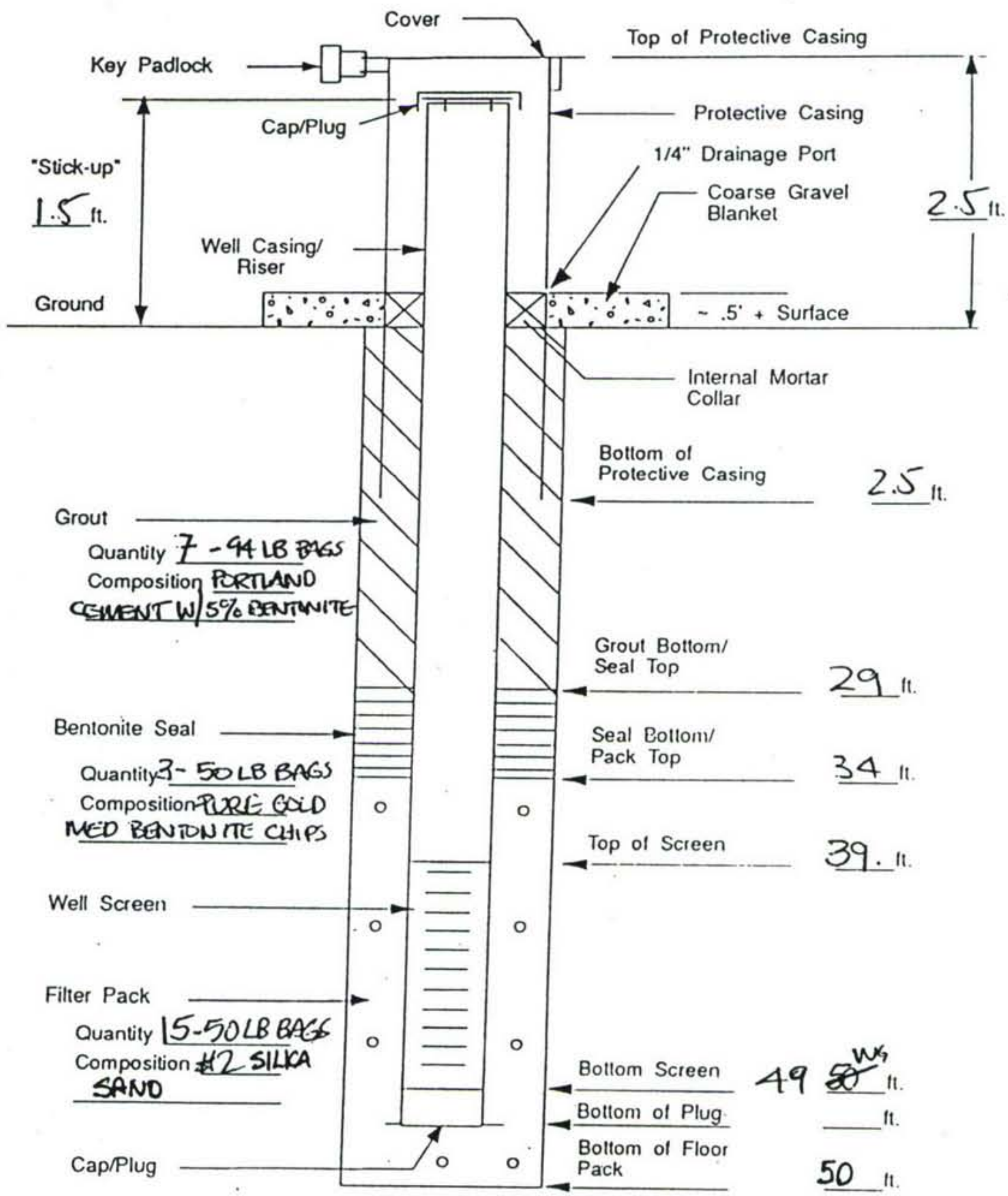
Page: 2 of ~~3~~ 5

Well Construction Log:
Site ID Number: P58
Well Number: E3-P58-M01
Today's Date: 8/12/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-P58-M01
Page 2 of 3
Signature: [signature]
Xerox:
Sent to USATHAMA:
Date Sent:
75

Project: SUDBURY ANNEX

Boring: E3-P58-MOL

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/12/93 Soil/Rock Description START/FINISH-0947/1730 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		DRY, LT BROWN FN GRAINED SAND LOOSE	SS1 0947 R=.5	1 1 1 1	NOTE: 1/SPLIT SPOONS ARE DRIVEN W/140 LB HAMMER W/30" FREEFALL
2		H_2O @ 5.0'			2/DEPTH & R IN FEET
4	▽	DK BROWN WET @ 5.0' SILT W/FNGR SAND. DARK BR-BLACK BANDING. METHANE HI II ON OVA	SS2 0854 R=1.0	1 1	3/8 1/4 HSAs 4/2" X 2' SPLIT SPOONS
		44 PPM OVA - METHANE			DRILLING NOTES:
6					1/DRIVE SPL SP 0-2
9		9-10' WET, LOOSE, GREY GRAVELLY SAND, FN/MD/CS = 50/30/20 GRAVEL 20% 10-11' GREY, LOOSE, FN GRAINED SAND. FN/MD = 90/10	SS3 0912 R=1.3	5 3 5 6	2/AUGER TO 4' 3/DR. SPL SP 4-6' 4/ H_2O @ 5.0' 5/AUGER TO 9' 6/DR-SPL SP 9-11
		OVA = 70 PPM - METHANE			7/AUGER TO 14'
11		GREY, WET LOOSE GRAVELLY SND SND FN/MD/CS = 70/20/10 GRAVEL SUBROUNDED PHYLLITES, QTZ ITES, GRANODIORITE. SND/GRAVEL = 80/20. OVA = 0.0 ppm	SS4 0917 R=1.0	2 1 2	8/DRIVE SPL SP 14-16 9/AUGER TO 19' 10/DRIVE SPL SP 19-21 11/AUGER TO 24' 12/DRIVE SPL SP 24-26'
14					
19		WET, LOOSE, GREY VERY FN GRAINED SAND. 10% FN GRAINED SND	SS5 0930 R=.5'	2 1 3	
		OVA = 0.0 ppm			
24		ORANGE-BR WET LOOSE FN GRAINED SAND - COLOR FROM FE STAINING	SS6 0942 R=1.0	2 2 3 3	
26		OVA = 0.0 ppm			

BORING LOG GENERAL DATA Bore Hole Number: E3-P58-MOL

Page: 2 of 2 Signature: Walter Xerox: [illegible] Sent to USATHAMA: Date Sent:

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BORING LOG GENERAL DATA
Borehole Number: E3-P58-M01
Page: 2 of
Signature: [illegible] Xerox:
Sent to USATHAMA: Date Sent:

Project: SUDBURY ANNEX | Boring: E3-P58-M01 | Page: ~~3~~ 4 of ~~8~~ 5

8/12/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
29		100% WET LOOSE VERY FN GR SAND ORANGE-BROWN FROM FE STAINING CLEAN, <10% FN GRAIN	SS7 0957 R=1.9	4 5 7 10	13/ AUGER TO 29' SILT @ 30' 14/ DRIVE SPL SP 29-31 15/ AUGER TO 34'
31		OVA = 0.0 PPM			16/ RUNNING SANDS WILL NOT PERMIT SPLIT SPOONS TO BE DRIVEN. MORE THAN 5' OF SAND IN AUGER WILL ATTEMPT TO COLLECT SPLIT SPOON @ 44-46' FOR TOC & GRAIN SIZE.
34		NO SAMPLE SEE NOTE 16	R=		17/ AUGER TO 44'
36					18/ DRIVE SPL SP 44-46'
39		NO SAMPLE ~~SEE~~ SEE NOTE 16	R=		19/ AUGER TO 50' 20/ TD = 50' 21/ INSTALL SCREEN 40'-50' 22/ ADDED ≈ ~~100~~ 75 w/g GAL OF WATER TO SET SCREEN
41					
44		GREY, WET VERY FN GRAINED SND W/SILT, HOMOGENEOUS, SILT INCREASING AT BASE OF SPOON	SS8 1042 R=1.0	7 9 8 9	23 LET BENTONITE SET @ 11:30 →
46					
50		TD = 50'	R=		SAMPLE 44-46 BX5801X1

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ecology and environment usagndat.pm4

BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3-P58-M01 Page: ~~1~~ 5 of 5

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/12/93 Completed: 8/12/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL-RAND - A - 300

First Encountered: 5.0' Date: 8/12/93

While Drilling: 5.0' Date: 8/12/93

At Boring Completion: Date: 8/12/93

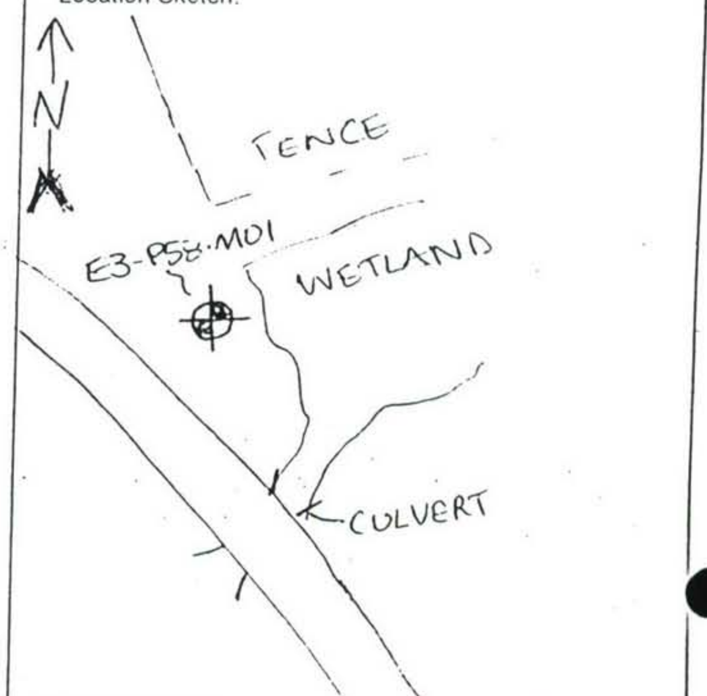
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/12/93	0847	1730	0	~~50~~ 50'					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______
Page: 1 of ______
Signature: ______
Xerox: ______
Sent to USATHAMA: ______
Date Sent: ______

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WELL CONSTRUCTION LOG

Page: 1 of ~~3~~ 4

Site ID: ______

Well Number: E3-P58-M02

Job Number: ______

Today's Date: 8/12/93

Well Start/Completion Dates: 8/12/93 / 8/12/93

Installation Difficulties: ______

Remarks: ______

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES

Schedule: 40

Type: Continuous Slot ______
Perforated ______
Louvre ______
Other X

Materials: Stainless Steel ______
PVC X
Other ______

Length: 10'

Screened Interval: 8-18'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Slot: Size (inches): 0.020 Configuration: HORIZONTAL 1/4" SPACING

Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES

Schedule: 40

Material: Stainless Steel ______
PVC X
Other ______

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: 0.25"

Joint(s): Design THREADED
Composition PVC
Depth(s) 8'

Centralizer: Design N/A
Composition
Depth(s)

Solvent, Glues, Cleaners: Manufacturer N/A
Use(s) ______

Protective Casing: Material CARBON STEEL
Inner Diameter 6"

WELL CONSTRUCTION LOG
Well Number: ______

Page 1 of 3
Signature: ______

Xerox: ______

Sent to USATHAMA: ______
Date Sent: ______

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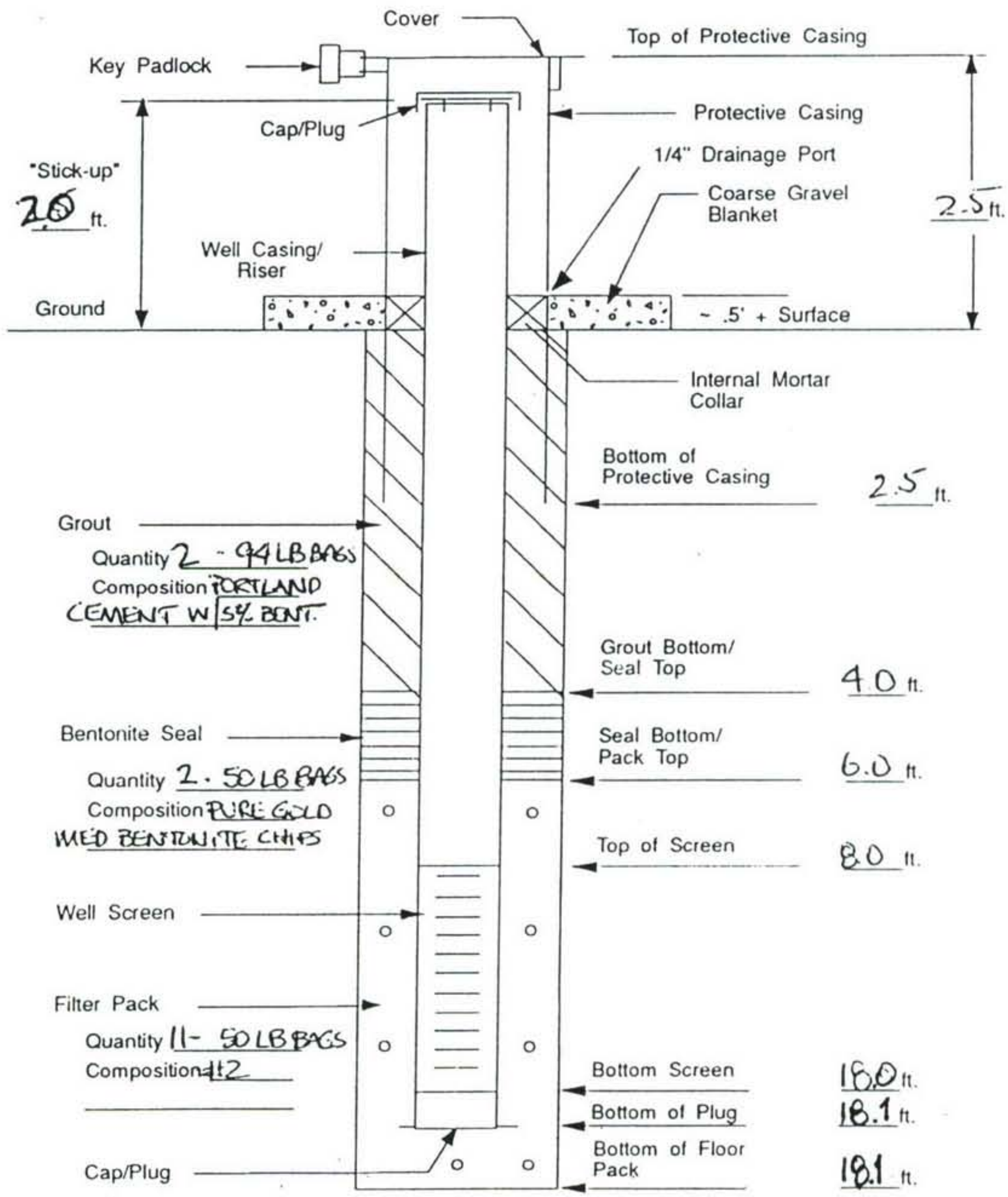
Well Construction Log: ______

Site ID Number: P58

Well Number: E3-P58-MO2

Today's Date: 8/12/93

WELL CONSTRUCTION



Sent to USATHAMA: ______
Date Sent: ______

Page 2 of 3
Xerox:
Signature: Walter Grd

WELL CONSTRUCTION LOG
Well Number: E3-P58-MO2

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Project: SUDBURY ANNEX

Boring: E3-P58-M02

8/12/93

START/FINISH 1359/~~15~~1754

GROUND SURFACE

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		DRY, LOOSE, BROWN TO LT BROWN FN GRAINED SAND	SS1 1359	1 1 1	NOTES: 1/ ~~140~~ SPLIT SPOONS DRIVEN W/140 LB HAMMER W/30" FREE FALL
2		OVA = 0.0 ppm			2/ DEPTH ~~FR~~ IN FEET
4		MOIST, LT BROWN-ORANGE FN/MD GR SAND W/MINOR GRAVEL (10%) FN/MD = 70/30. LOOSE, GRAVEL SUBROUNDED VERY MOIST @ BOTTOM	SS2 1408	2 3 3 3	3/ 8¼" HSAs 4/ 2" X 2' SPLIT SPOON
6	▽	OVA = 0.0 ppm H_2O = 5.5'			DRILLING NOTES: 1/ DRIVE SPLIT SPOONS 0-2'. 2/ AUGER TO 4'
9		WET, LOOSE, DK BROWN GRAVELLY SND. FN/MD/CS = 60/20/20, SND/GRAVEL = 80/20 10-11' FN/MD GRAINED SND, WET LOOSE FN/MD = 90/10	1419 R=1.4	5 3 2 2	3/ DRIVE SPL SP 4-6'. H_2O = 5.5' 4/ AUGER TO 9' 5/ DRIVE SPL SP 9-11'
11		OVA = 6.0 ppm			6/ AUGER TO 14' 7/ DRIVE SPL SP 14-16'
14		WET LOOSE TAN FN GRAINED SND VERY FN/FN = 30/70%	1422 R=1.3	WOR* ↓	8/ AUGER TO 18' 9/ INSTALL WELL SCREEN 18'-8' 10/ ALLOW BENTONITE TO SET 1515→1530
16		*WOR = WEIGHT OF RODS			SAMPLE 411 BX5802X1

BORING LOG GENERAL DATA

Borehole Number: E3 P58-M02

Page: 2 of

Signature: Walter Grof

Approx:

Sent to USATHAMA:

Date Sent:

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3-P58 M02 Page: 4 of 4

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/12/93 Completed: 8/12/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A-300

First Encountered: 5.5' Date: 8/12/93

While Drilling: 5.5 Date: 8/12/93

At Boring Completion: 5.5' Date: 8/12/93

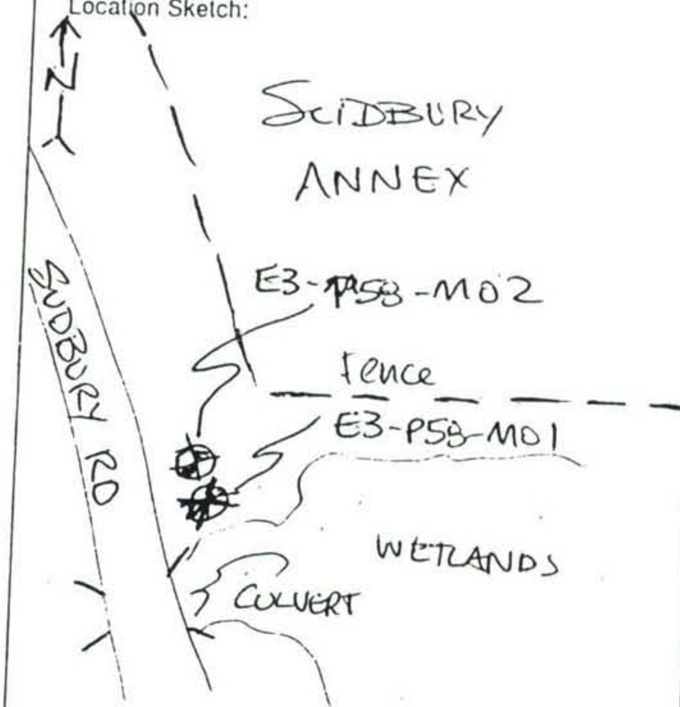
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/12/93	1359	1754	0	18					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: E3-P58-M02
Page: 1 of
Signature: Walter Graf
rox:
Sent to USATHAMA:
Date Sent:

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WATERSHED 6

GROUNDWATER MONITORING WELLS

E3-P02-M01
E3-P03-M01
E3-P03-M02
E3-P03-M03 (ABANDONED)

SUDBURY ANNEX

WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX
Well Number: E3 - P02 - M01
Job Number:
Today's Date: 8/12/93
Well Start/Completion Dates: 8/12/93, 8/12/93

Page: 1 of 4

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Type: Continuous Slot HORIZONTAL
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 10'

Screened Interval: 8'-18'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Slot: Size (inches): .020" Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Material: Stainless Steel
PVC X
Other

Length: 10'

Diameter: (ID) 4.0" (OD) 4.5"

Thickness: .25"

Joint(s): Design THREADED
Composition
Depth(s) 8'

Centralizer: Design N/A
Composition
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)

Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

Sent to USATHAMA:
Date Sent:
Xerox:
Page 1 of 3
Signature:

WELL CONSTRUCTION LOG
Well Number:

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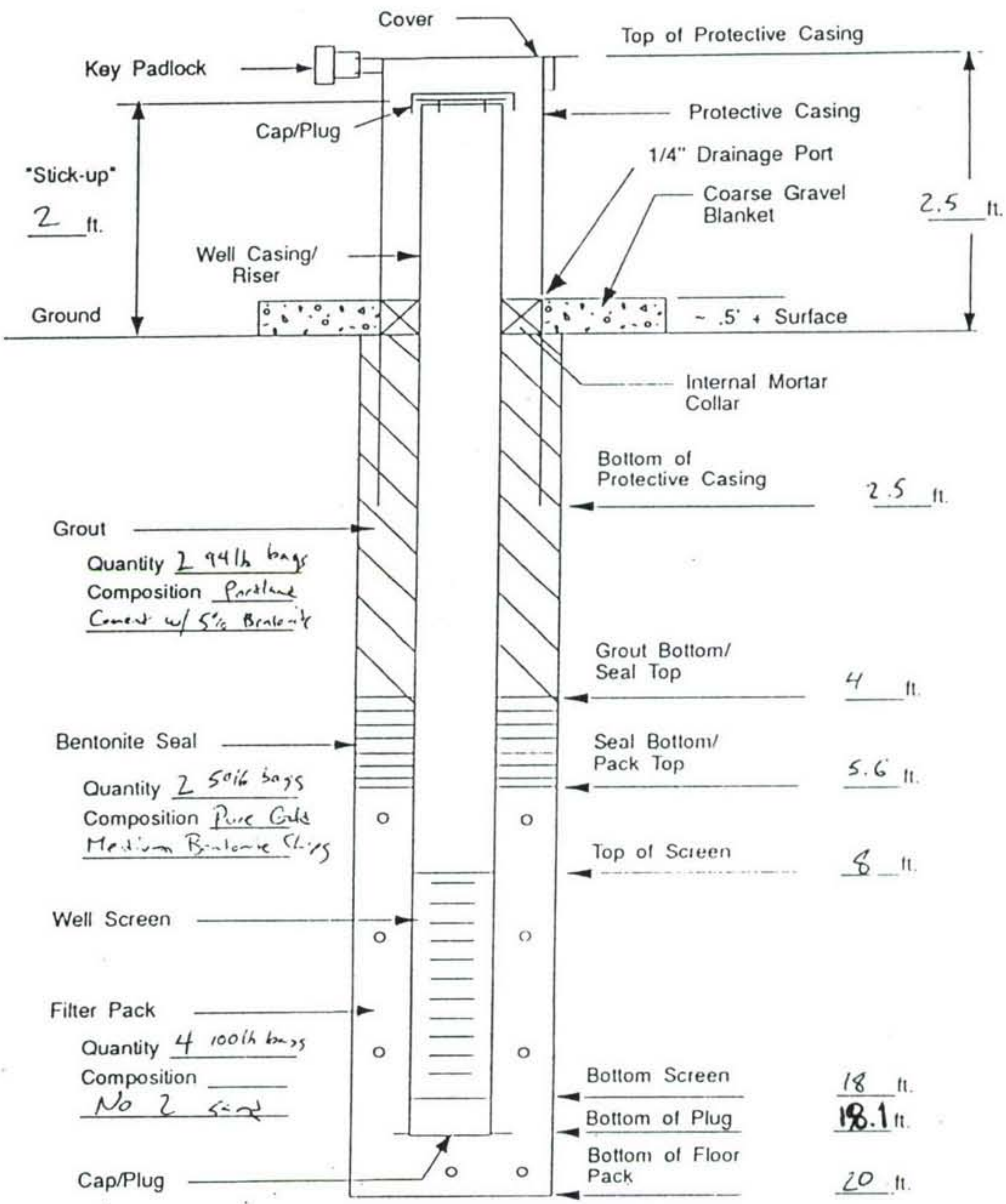
Well Construction Log:

Site ID Number:

Well Number: E3 - PØ 2 - MØ 1

Today's Date: 8/12/93

WELL CONSTRUCTION



Sent to USATHAMA: ______ Date Sent: ______

Page 2 of 3 Xerox: ______ Signature: ______

WELL CONSTRUCTION LOG

Well Number: ______

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Project: Sudbury Annex

Boring: E3-~~BP02~~-M01

Page: ~~2~~ 3 of ~~3~~ 4

8/12/93

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery
		GROUND SURFACE		
0		0-0.1 - organic layer 0.1-0.8 - Silty Sand; med brn → drk brn; low moisture; 40%F, 60%M; 10-20% gravels up to 1" diam 0.8-1.2' - Silty Sand: drk brn; low moisture 40%F, 60%M; dense; no gravels; iron staining & glass shards at 1.2'	SS1 OVA=0ppm	2, 4 6, 7 1.2'R
2		3' Silty Sand; lt. brn; low moisture; 30%F 70%M; few very small gravels		
4		4.0-4.4 -> Sand as above 4.4-5.2' Silty Sand; lt. brn; low moisture; 20%F, 40%M, 40%C; very low silt content	SS2 OVA=0ppm	1.2'R
6				
9		9.0-9.4' Sand as above 9.4-10.5' Silty Sand, lt brn; no St; 60%F, 40%C; very low silt content 10.5-10.7' Silty Sand; lt brn → red brn; wet 60%F, 40%C; low silt content	SS3 OVA=0ppm	3, 4, 4, 7 1.7'R
10.5 ▽				
11		Sand as above - Clay increasing w/ depth		
14		Clayey Sand; med brn; wet; 80%F, 20%M 20-30% Clay; dense; low plasticity	SS4 OVA=0ppm	3, 7, 13, 13 1.8'R
16		Sand as above		
19		TD = 19'		

Drilling Data

START/FINISH - 0959/1130

NOTE:
1/ SPLIT SPOONS ARE DRIVEN W/ 140 LB HAMMER W/ 30" FREEFALL
2/ DEPTH & R IN FEET
3/ 6¼" HSAs
4/ 2" X 2' SPLIT SPOONS

DRILLING NOTES:
1) DRIVE SPL SP 0-2'
2) AUGER TO 4'
3) DRIVE SPL SP 4-6
4) AUGER TO 9'
5) DRIVE SPL SP 9-11
6) H_2O @ ≈ 10.5'
7) AUGER TO 14'
8) DRIVE SPL SP 14-16'
9) AUGER TO 19'
10) TD = 19'

SAMPLE

14-16 BX0201X1

BORING LOG GENERAL DATA
Borehole Number: E3-P02-M01
Page: 2 of
Signature:
Sent to USATHAMA:
Date Sent:
33

BORING LOG GENERAL DATA
Borehole Number: ______
Page: 1 of ______
Signature: ______
Xerox: ______
Sent to USATHAMA: ______
Date Sent: ______

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BORING LOG GENERAL DATA

Project: Sudbury Annex   Boring: E3-PØ2-MØ1   Page: 4 of 4

Driller & Company: Dave Gagne - ESD

Geologist/Logger & Company: John Pasch / E&E   Signature: [signature]

Date Boring Started: 8/12/93   Completed: 8/12/93

Water Levels (from Ground Surface)   Drilling Rig: Mobil

First Encountered: 10.5   Date: 8/12/93

While Drilling: 10.5   Date: 8/12/93

At Boring Completion: 10.5   Date: 8/12/93

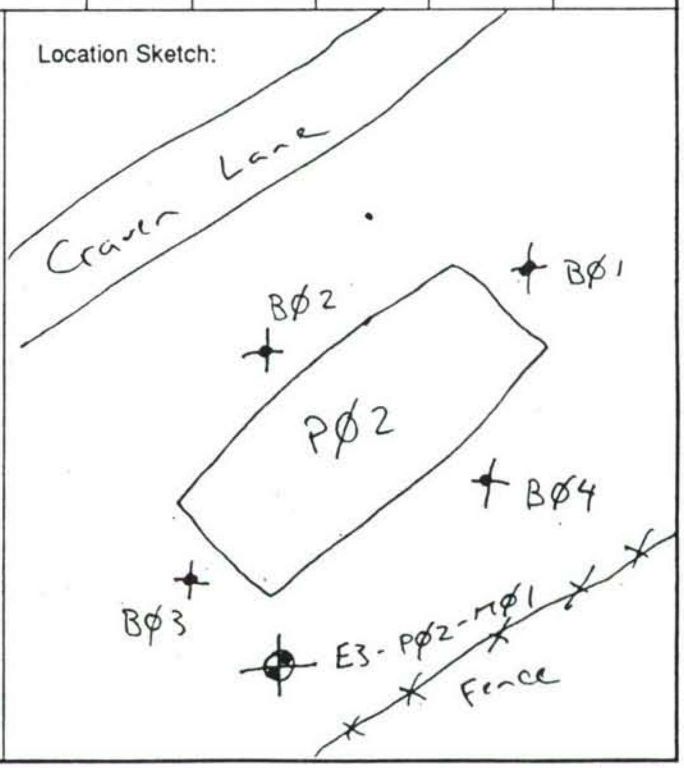
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/12	0959	1130	0'	19'					

Abbreviations:

Abbr.	Meaning
SS	split spoon
R	recovery
F	fine
M	medium
C	coarse
HSA	hollow stem auger
ID	inner diameter
SAA	same as above

Location Sketch:



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SUDBURY ANNEX

WELL CONSTRUCTION LOG Site ID: Well Number: E3-P03-M01 Job Number: Today's Date: 8/27/93 Well Start/Completion Dates: 8/27/93, 8/27/93	Page: 1 of 3 Installation Difficulties: NONE Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES

Schedule: 40

Type: Continuous Slot HORIZONTAL

Perforated

Louvre

Other

Materials: Stainless Steel

PVC X

Other

Length: 10'

Screened Interval: 59'-49'

Diameter: (ID) 2.0" (OD) 2.25"

Thickness: .125"

Slot: Size (inches): .02" Configuration: HORIZONTAL SLOT

Open Area per Foot of Screen: 6.27in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES

Schedule: 40

Material: Stainless Steel

PVC X

Other W/S

Length: ~~50~~ 10'

Diameter: (ID) 2.0" (OD) 2.25"

Thickness: .125"

Joint(s): Design THREADED

Composition

Depth(s) EVERY 10 FEET (49, 39, 29, 19, 9)

Centralizer: Design

Composition N/A

Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE

Use(s)

Protective Casing: Material HARDENED STEEL

Inner Diameter 6"

Sent to USATHAMA:

Date Sent:

Page 1 of 3 Xerox:

Signature: Walter Gray

WELL CONSTRUCTION LOG

Well Number: E3-P3-M01

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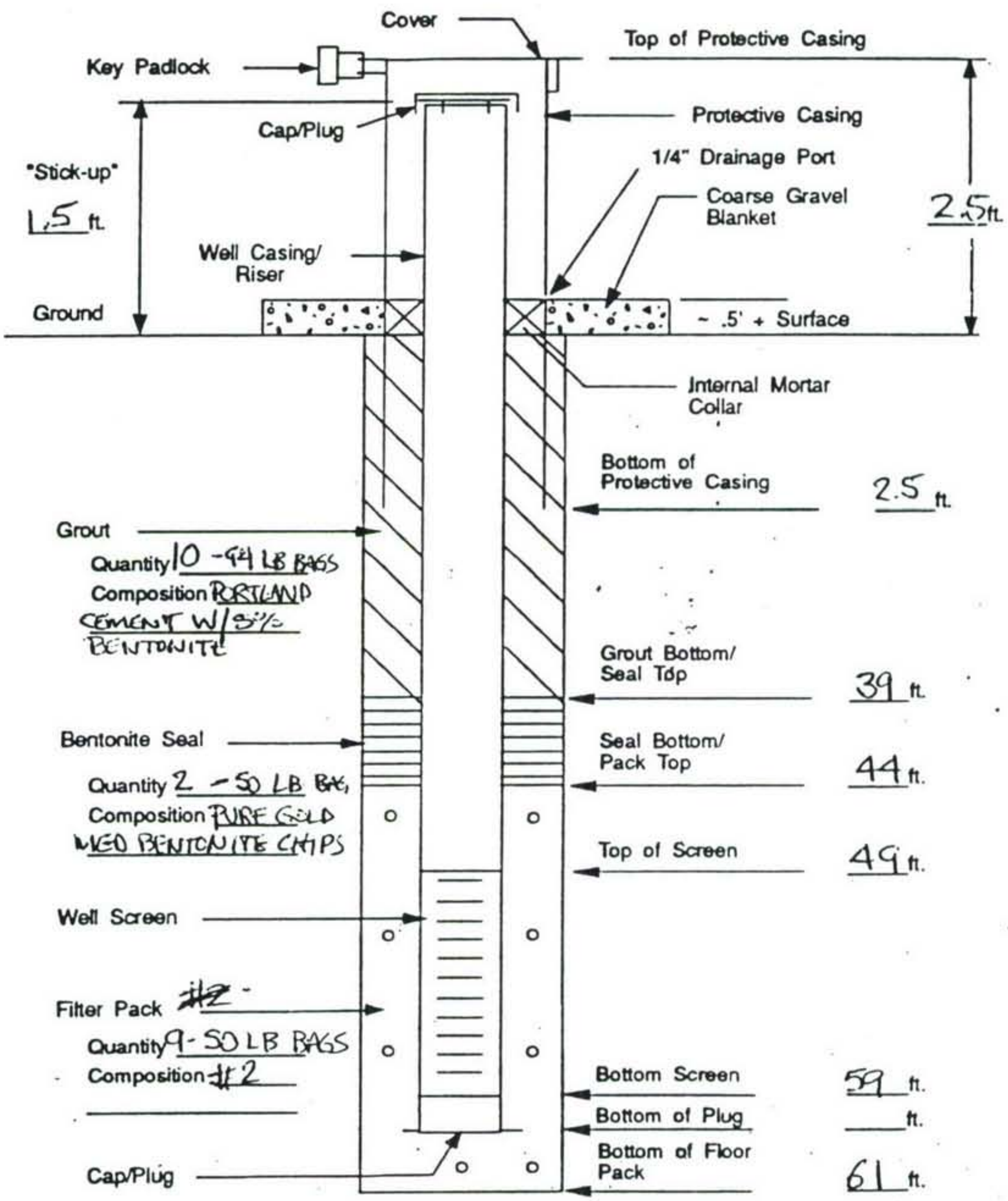
Well Construction Log:
Site ID Number:
Well Number: E3-P3-M01
Today's Date: 8/27/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-P3-M01

Page 2 of 3 Xerox:
Signature: Walter Gray

Sent to USATHAMA:
Date Sent:

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Project: SUDBURY ANNEX

Boring: E3-P3-MS1

Page: 3 of 6

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (8/13/93; START / FINISH - 0810/1520; GROUND SURFACE)	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-.5 DK BROWN SANDY SILT DRY LOOSE .5-1.5 LT BR - DRY, LOOSE SANDY SILT W/GRAVEL 1.5-2.0 - TAN SANDY SILT, COMPACT, DRY, W/GRAVEL. SILT/GRAVEL = 90/10	SS1 0013 R=1.0	5 11 13 31	NOTES: 1/ SPLIT SPOONS DRIVEN W/140 LB HAMMER W/A 30" FREE FALL. 2/ DEPTH & "R" IN FEET 3/ 8¼" HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		DRY TAN SILT W/GRAVEL, FE STAINS VERY TIGHT. GRAVEL WEATHERED ~~FINE~~ GRANODIORITE, QTZITE, PHYLLITES ~~MORE~~ CLAY INCREASING @ 6'	SS2 0827 R=1.8	18 17 30 37	DRILLING NOTES: 1/ DRIVE SPL SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPL SP 4-6'
6					
9		LT BR - TAN, DRY, DENSE, CLAYEY SILT W/WEATHERED ROCK, PHYLLITE, QTZITE GRANODIORITES. GLACIAL TILL	0918 R=1.9'	19 25 47 49	4/ AUGER TO 9' 5/ DRIVE SPL SP 9-11' 6/ AUGER TO 13' - STOP DRILL CANNOT DRIVE 8¼" AUGERS 7/ CHANGE TO 4¼" HSAS 8/ AUGER TO 14"
11					
14		LT BR, DRY, DENSE, CLAYEY TILL W/WEATHERED ROCK AS ABOVE GLACIAL TILL. SOME BLACK STAINING	1457 R=1.8	20 34 48 53	9/ DRIVE SPL SP 14-16' 10/ AUGER TO 18½' REFUSAL - ABANDON HOLE 11/ GROUT 18½' TO SURFACE
16					
19			R:		SAMPLES NONE COLLECTED - HOLE ABANDONED
21					

BORING LOG GENERAL DATA
Borehole Number: E3-P3-M01

Page: 2 of

Signature: ________ Xerox: ________

Sent to USATHAMA: ________ Date Sent: ________

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Project: SUDBURY ANNEX	Boring: E3-P3-MO1	Page: ~~2~~ 4 of 6

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	8/27/93 Soil/Rock Description START/FINISH 0830/1042 GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		SEE BORING LOG FOR P3-MO1 (HOLLOW STEM AUGER) FOR INITIAL 18'.			1/ DRILL IS CANTERRA CT550, AIR ROTAR 2/ AIR ROTARY DRILL ~~0~~ 0-63' 3/ H_2O @ 25' while drilling
25'	∇	H_2O @ ≈ 25.5' while DRILLING HAMMER BECAME TIGHT ~~in~~ IN MATERIAL. NO BR ENCOUNTERED			4/ TD 63.0' 5/ BOTTOM OF SCREEN @ 59'. LAST 2' OF BORING HAS CUTTINGS THA ~~WERE~~ FELL BACK TO THE BOTTOM APPROX. 2' OF FILTER PACK BELOW SCREEN
35'		CUTTINGS: GREY-BROWN, MOIST LESS ROCK FRAGMENTS THAN THE TILL ABOVE ~~of~~ (TO 18')			6/ NO SAMPLES COLLECTED
63		TD = 63'. BEDROCK NOT ENCOUNTERED			

BORING LOG GENERAL DATA
Borehole Number: E3-P3-MO1
Page: 2 of
Signature: Walter Gray
Xerox:
Sent to USATHAMA:
Date Sent:
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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: P3-M01 Page: ~~1~~ 5 of 6

Driller & Company: PAUL SHIMKO / ESP

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/27/93 Completed:

Water Levels (from Ground Surface) Drilling Rig: CANTERRA CT550

First Encountered: ≈25 Date: 8/27/93

While Drilling: ≈25 Date: 8/27/93

At Boring Completion: 39.6' Date: 8/27/93

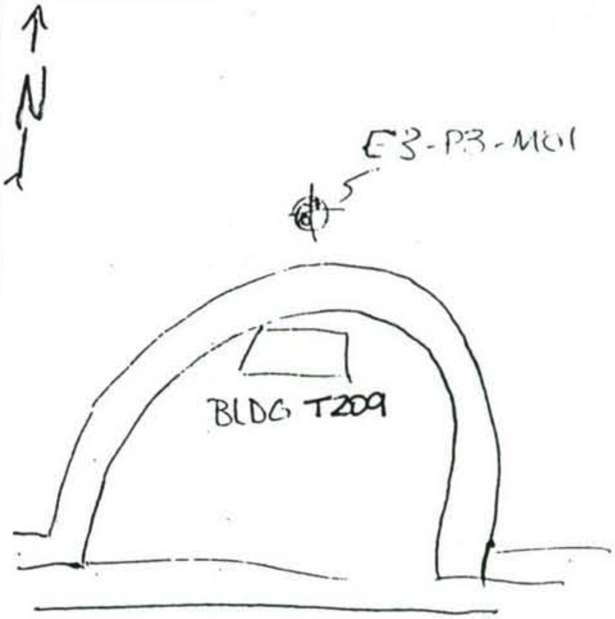
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/27	~~0803~~ 0830	1042	0	63					

Abbreviations:

Abbr.	Meaning

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ______ Page: 1 of ______ Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

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WELL BORING ABANDONMENT LOG
Well Number: ______
Page: 1 of 1
Signature: ______
Xerox: ______
Sent to USATHAMA: ______
Date Sent: ______
81

WELL BORING ABANDONMENT LOG

Site ID: P3

Well /Boring Number: E3-P3-M01

Job Number: ______

Date: 8/13/93

1. Location with respect to replacement well/boring (if any): ~~N/A~~ 8 10' NW

2. Original Well/Boring:

Water/mud level prior to grouting: Date: ______ Level: N/A

Open depth prior to grouting: 18.5'

Depth to which grout pipe was placed: ______

Total quantity of grout used during initial grouting: 2 94 LB BAGS OF PORTLAND CEMENT W/5% BENTONITE

Daily quantities of grout used to compensate for settlement: ______

3. Casing left in hole: Depth: / Composition: / Size: N/A

Remaining casing above ground surface: Stick-up: / Composition: / Size: N/A

4. Items left in hole: Depth: / Description: / Composition: NONE

5. Total drilling depth of original hole: 18.5'

6. Sampling depths within original hole: ______

7. Attach a copy of the Boring Log.

8. Attach a copy of the Construction Diagram.

Abandoned By: Walter Graf Date: 8/13/93

USAWBAL.PM4

WELL CONSTRUCTION LOG

Site ID: SUDBURY ANNEX
Well Number: E3-P3-M02
Job Number:
Today's Date: 8/16/93
Well Start/Completion Dates: 8/16/93 / 8/16/93

Page: 1 of ~~3~~ 5

Installation Difficulties:

Remarks:

Check as appropriate, record depths as below ground surface (BGS)

Screen:

Manufacturer: BEDROCK ENTERPRISES, INC.
Schedule: 40
Type: Continuous Slot HORIZONTAL
Perforated
Louvre
Other

Materials: Stainless Steel
PVC X
Other

Length: 8.0'
Screened Interval: ~~'-16~~ 15.5'-7.5'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Slot: Size (inches): .020 Configuration: HORIZONTAL SLOT
Open Area per Foot of Screen: 6.27 in²/ft

Casing

Manufacturer: BEDROCK ENTERPRISES, INC
Schedule: 40
Material: Stainless Steel
PVC X
Other

Length: 10'
Diameter: (ID) 4.0" (OD) 4.5"
Thickness: .25"
Joint(s): Design THREADED
Composition
Depth(s) 7.5'

Centralizer: Design
Composition N/A
Depth(s)

Solvent, Glues, Cleaners: Manufacturer NONE
Use(s)

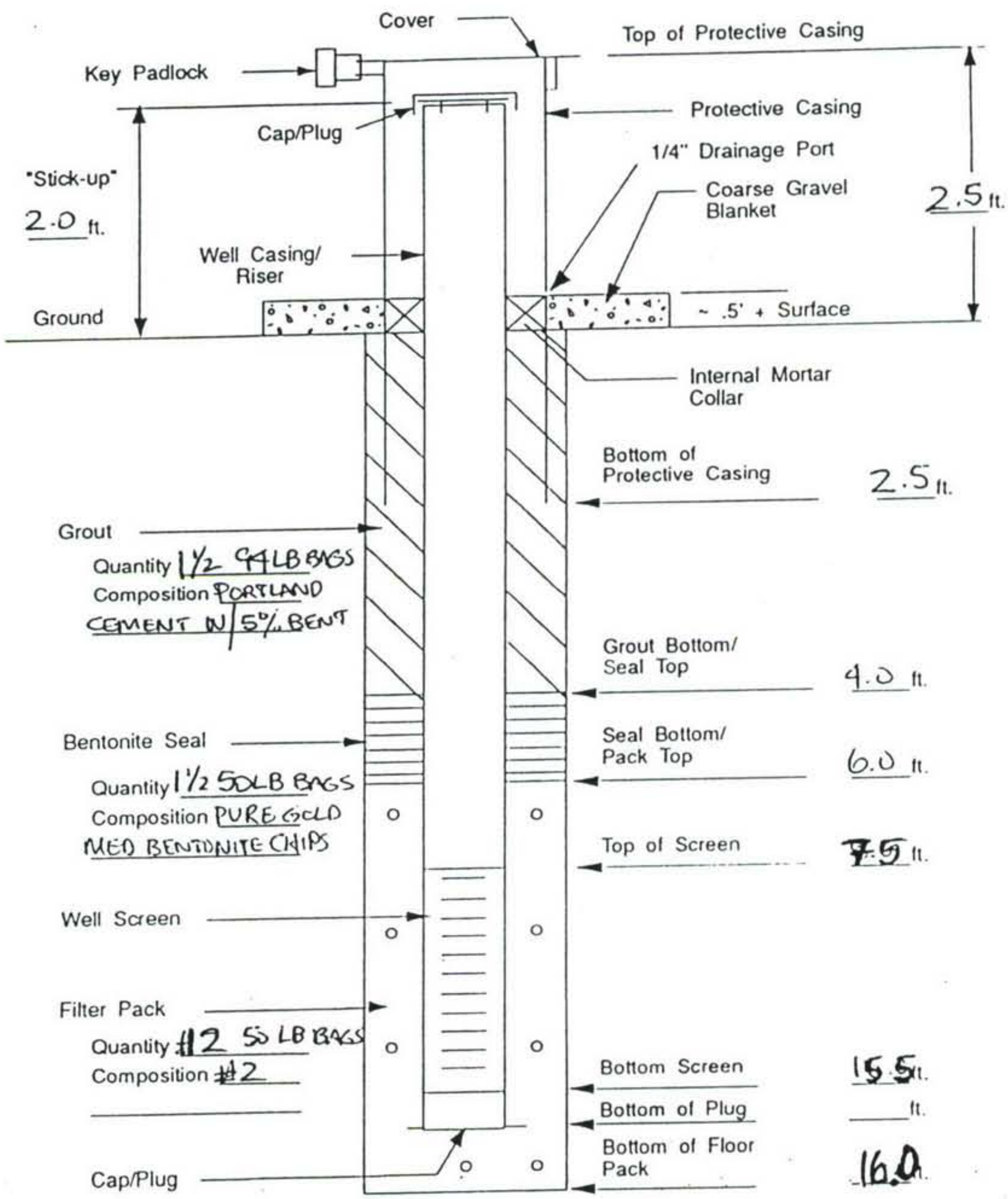
Protective Casing: Material HARDENED STEEL
Inner Diameter 6.0"

usainfo.cdr

Sent to USATHAMA:
Date Sent:
Page 1 of 3 Xerox:
Signature:
WELL CONSTRUCTION LOG
Well Number:
48

Well Construction Log:
Site ID Number: P3
Well Number: E3-P3-M02
Today's Date: 8/16/93

WELL CONSTRUCTION



WELL CONSTRUCTION LOG
Well Number: E3-P3-M02
Page 2 of 3
Signature: [illegible] Xerox:
Sent to USATHAMA:
Date Sent:
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usainfo2.cdr

Project: SUDBURY ANNEX

Boring: E3-P3-M02

Page: 3 of 5

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description (3/16/93; START/FINISH - 0817/1125) GROUND SURFACE	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		DRY BR SANDY SILT - 0-.5' DRY FN GRAINED GRAVELLY SND. LOOSE LT BROWN OVA = 0.0 ppm	0812 R=1.0	2 3 3 4	NOTES: 1/ SPLIT SPOONS DRIVEN W/140 LB HAMMER W/A 30" FREE FALL. 2/ DEPTH & "R" IN FEET 3/ 8 1/4 HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		GREY, BROWN TIGHT, VERY MOIST FN GRAINED SAND W/SILT & WEATHERED GRAVELS FE STAINING. GRAVELS ARE PHYLLITO GRANODIORITE, QTZITES = TILL OVA = 0.0 ppm	0832 R=1.5	13 21 22 13	DRILLING NOTES 1/ DRIVE SPL SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPL SP 4 TO 6' 4/ AUGER TO 9' 5/ AUGER REFUSAL @ 8' MOVE 5' AUGER TO 9'
6					
9		GREY BR. TIGHT VERY FN GRAINED SAND W/SILT AS ABOVE 9-9.5' 9.8-10.5' MD-CS GRAINED SAND W/ WEATHERED GRAVELS & FINES. WET OVA: 0.0 ppm FN/MD/CS = 30/40/30 10.5-11' LT BROWN FN GRAINED SILTY SND NO GRAVEL SILT/SND = 50/50 H2O @ 9.5'	0942 R=1.3	10 12 12 13	6/ DRIVE SPL SP 9'-11' 7/ H2O @ 9.5'
11					8/ AUGER TO 14'
14		14-14.7' BR, WET, SILTY SAND NO GRAVEL (AS ABOVE 14.7-16.0 BROWN, TIGHT SILT W/CLAY SILT/CLAY 80/20%, MINOR (<10%) GRAVEL 7 WEATHERED GRANODIORITE PHYLLITE OVA = 0.0 ppm	1007 R=2.0	14 21 21 29	9/ DRIVE SPL SP 14-16' 10/ AUGER TO 16' 11/ WILL SET WELL SCREEN 8'-16'. 12/ TD 16'
16		TD - 16.0'			SAMPLES 9-11' BX0302X1

Sent to USATHAMA: ______ Date Sent: ______

Page: 2 of ___ Xerox: Signature: Walter Grof

BORING LOG GENERAL DATA Borehole Number: E3-P3-M02

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX Boring: E3 P3 M02 Page: 4 of 5

Driller & Company: MARK THIBODEAU / ESD

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 8/16/93 Completed: 8/16/93

Water Levels (from Ground Surface) Drilling Rig: INGERSOLL RAND A-300

First Encountered: 9.5' Date: 8/16/93

While Drilling: 9.5' Date: 8/16/93

At Boring Completion: 9.5 Date: 8/16/93

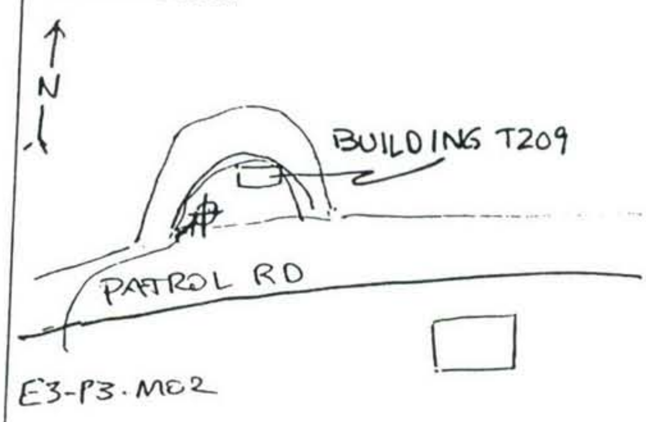
Drilling Shifts: 1

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/16/93	0817	1125	0	16.0'					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY
VRY	VERY
BR	BROWN

Location Sketch:



BORING LOG GENERAL DATA
Borehole Number: ____
Page: 1 of ____
Signature: ____
Xerox: ____
Sent to USATHAMA: ____
Date Sent: ____

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WELL BORING ABANDONMENT LOG

Site ID: P3
Well /Boring Number: E3 P3-MS2 (1ST ATTEMPT AT THIS LOCATION)
Job Number:
Date: 8/16/93

1. Location with respect to replacement well/boring (if any): 5' WEST

2. Original Well/Boring:

Water/mud level prior to grouting: Date: 8/16/93 Level: —
Open depth prior to grouting: 8.0'
Depth to which grout pipe was placed:
Total quantity of grout used during initial grouting:
Daily quantities of grout used to compensate for settlement:

3. Casing left in hole: Depth: / Composition: / Size: N/A

Remaining casing above ground surface: Stick-up: / Composition: / Size: N/A

4. Items left in hole: Depth: / Description: / Composition: NONE

5. Total drilling depth of original hole: 8.0'

6. Sampling depths within original hole: 0-2', 4-6'

7. Attach a copy of the Boring Log. N/A

8. Attach a copy of the Construction Diagram. N/A

Abandoned By: Walter Graf Date: 8/16/93

WELL BORING ABANDONMENT LOG
Well Number:
Page: 1 of 1
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:
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WELL BORING ABANDONMENT LOG

Site ID: ____________

Well /Boring Number: E3-P3-M03

Job Number: ____________

Date: 8/16/93

1. Location with respect to replacement well/boring (if any): N/A

2. Original Well/Boring:

Water/mud level prior to grouting:	Date: ______ Level: ______
Open depth prior to grouting:	
Depth to which grout pipe was placed:	13.5'
Total quantity of grout used during initial grouting:	5-94 lb BAGS PORTLAND CEMENT W/5% BENTONITE
Daily quantities of grout used to compensate for settlement:	

3. Casing left in hole: Depth: / Composition: / Size: N/A

   Remaining casing above ground surface: Stick-up: / Composition: / Size: N/A

4. Items left in hole: Depth: / Description: / Composition: N/A

5. Total drilling depth of original hole: 13.5'

6. Sampling depths within original hole: 0-2', 4-6', 9-11'

7. Attach a copy of the Boring Log.

8. Attach a copy of the Construction Diagram. N/A, BOREHOLE

Abandoned By: Walter Graf   Date: 8/16/93

WELL BORING ABANDONMENT LOG
Well Number: ______ Page: 1 of 1 Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______
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USAWBAL.PM4

Project: SUDBURY ANNEX

Boring: E3 P3 M03

Page: 2 of 3

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		8/16/93 START/FINISH - 1201/1315 GROUND SURFACE			
		DRY, LOOSE, FN GRAINED SAND W/GRAVEL	1202 R=.5'	20 20	NOTES: 1/ SPLIT SPOONS DRIVEN W/140 LB HAMMER W/A 30" FREE FALL. 2/ DEPTH & "R" IN FEET 3/ 8 1/4" HSAs 4/ 2" X 2' SPLIT SPOONS
2					
4		MOIST, LT BR, TIGHT, VRY. FN GRAINED SAND W/SILT & WEATHERED GRAVEL OF GRANODIORITE, PHYLLITE, & QTZITE INCREASING SILT AT BOTTOM OF SPOON	1211 R=1.2	7 13 15 17	DRILLING NOTES 1/ DRIVE SPLIT SP 0-2' 2/ AUGER TO 4' 3/ DRIVE SPL SP 4-6' 4/ AUGER TO 9' 5/ DRIVE SPL SP 9'-11' 6/ AUGER REFUSAL AT 13.5' 7 GROUT HOLE 13.5' → SURF
6					
9		MOIST, TIGHT, LT BROWN CLAYEY SILT W/WEATHERED GRAVEL (PHYLLITES, GRANODIORITE. SOME FE STAINS ~~APP~~ CLAY/SILT = 20/80%	1304 R=1.7	8 11 16 20	
11		ABANDONED WELL			
14					
16					

BORING LOG GENERAL DATA
Borehole Number: E3-P3-M02
Page: 2 of
Signature:
Xerox: Walter Grady
Sent to USATHAMA:
Date Sent:

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BORING LOG GENERAL DATA

Project: SUDBURY ANNEX   Boring: Page: 3 of 3

Driller & Company: MARK THIBIDEAU | ESD

Geologist/Logger & Company: W. GRAF | E&E   Signature: Walter Graf

Date Boring Started: 8|16|93   Completed: 8|16|93

Water Levels (from Ground Surface) NOT ENCOUNTERED   Drilling Rig: INGERSOLL RAND - A-300

First Encountered: N/A   Date:

While Drilling: N/A   Date:

At Boring Completion: NO WATER   Date:

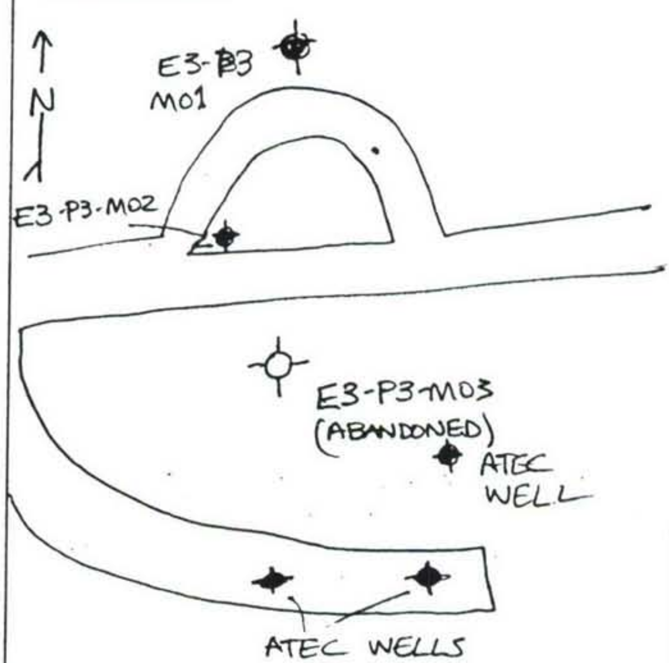
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
8/16	1201	1315	0	13.5					

Abbreviations:

Abbr.	Meaning
SPL SP	SPLIT SPOON
R	RECOVERY

Location Sketch:



BORING LOG GENERAL DATA   Page: 1 of   Sent to USATHAMA: Date Sent:

Borehole Number: Signature: Xerox:

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APPENDIX C

TEST PIT LOGS

APPENDIX C

TEST PIT LOGS

Appendix C contains field test pit logs for all test pit excavations completed at the Sudbury Annex by Ecology and Environment, Inc. Please refer to Section 5.1.2 of Volume I for a description of test pit excavation and abandonnment procedures. The test pit logs are organized by watershed. Please note that test pit excavations did not occur in Watersheds 3, 4, 5, and 6.

WATERSHED 1A

Test Pits

E3-P56-P01
E3-P56-P02
E3-P56-P03

34 BORING LOG GENERAL DATA Page: 3 of ___ Xerox: ___ Sent to USATHAMA: ___

Borehole Number: ___ Signature: ___ Date Sent: ___

Project: Sudbury - Test Pits 9/20/93 **Boring:** E3-PS6-~~P01~~ **Page:** 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1200 → 1240
0		High Organics; dense roots drk brn → blk			
1		Silty Sand; med. brn; 40%F 60% M; moderate moisture; minor clay present	E3PS6Ø11 (1.5')		OVA = 0ppm
2		Silty Sand; very lt. brn; 50% F, 50% M; moderate moisture; clean, loose; some iron staining			
3					
4					
5		TD = 5.5'	E3PS6012 (5.5')		OVA = 0ppm
6					

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BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

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Project: Sudbury - Test Pits 9/20/93 | Boring: E3-P56-P02 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1340 → 1355
		High organics; dense roots drk brn → blk			
1	- - - -	Silty sand; med brn w/ darker organic rich layers; 40%F, 60%M; moderate moisture; some clay	→ E3P56Ø21 (1')		OVA = 0ppm
2		Silty Sand; very lt. brn; 50%F, 50% M; moderate to low moisture; some iron stained bands			
3					
4					
5		TD = 5.5'	E3P56Ø22 (5.5')		OVA = 0ppm
6					

usagndat.pm4

BORING LOG GENERAL DATA 34
Borehole Number: ______ Page: 3 of ______ Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

Project: Sudbury - Test Pits 9/20/93 **Boring:** E3-P56-PØ3 **Page:** 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1600 → 1615
0		High Organics; blk; moist some silt present			
1		Silty Sand; med. brn; 40% F, 60% M moderate moisture; 10-20% clay.	E3P56Ø31		OVA = 0ppm
2					
3					
4		Silty Sand; very lt. brn; 50% F, 50% M; clean; wet			
5	▽				
		TD = 5.5'	E3P56Ø22		
6					

usagndat.pm4

WATERSHED 1B

Test Pits

E3-P26-P01
E3-P26-P02
E3-P26-P03
E3-P26-P04
E3-P26-P05
E3-P26-P06

BORING LOG GENERAL DATA
Borehole Number:
Page: 3 of
Signature:
Xerox:
Sent to USATHAMA:
Date Sent:

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Project: Sudbury - Test Pits - 9/21/93 | **Boring:** E3-P26-PØ1 | **Page:** 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 0840 → 0855
0		Silty sand; 20%F, 40%M, 40%C; lt. brn; low moisture; 20-30% gravels up to 1/4" diam; disturbed little surface vegetation.			
1		Silty sand as above; some layers w/ increased gravel content; significant iron staining throughout	E3P26PØ11		OVA = 0ppm
2					
3					
4		Silty Sand: lt. brn; 40%F, 60%M wet at 5.5'; clean; 4" iron stained band at 5'			
5	∇				
6		TD=6'	E3P26PØ12		OVA = 0ppm

usagndat.pm4

BORING LOG GENERAL DATA
Borehole Number: ________ Page: 3 of ________ Signature: ________ Xerox: ________ Sent to USATHAMA: ________ Date Sent: ________

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Project: Sudbury - Test Pits - 9/21/93 | Boring: E3-P26-PØ2 | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 0930 → 0955
0		Silty sand; 60% F, 40% M; med → drk brn; few gravels; high silt content; stained from 1-2'.			
1			E3P26PØ21		OVA = 0ppm
2		Silty Sand; 20% F, 40% M, 40% C; lt. brn; some gravels up to 1/4" diam; some darker banding			
3					
4					
5	▽	TD = 5'	E3P26PØ22		OVA = 0ppm
6					

usagndat.pm4

BORING LOG GENERAL DATA
Borehole Number: ______
Page: 3 of ______ Signature: ______
Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

Project: Sudbury - Test Pits - 9/21/93

Boring: E3-P2C-PØ3

Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1015 → 1045
0		High organics; blk			
1		Silty sand; med brn → drk brn; 20% F, 40% M, 40% C; alternating bands of organics; few gravels	E3P2CPØ31 (1')		OVA = 0 ppm
2					
3		Silty sand; gray brn; 70% F, 30% M; clean, dense; wet.			
4	∇				
		TD = 4.5'	E3P2CPØ32		OVA = 0 ppm
5					

usagndat.pm4

Project: Sudbury - Test Pits - 9/21/93

Boring: E3-P26-PØ4

Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1140 -> 1215
0		Silty Sand; lt. brn -> med brn; 20%F, 60%M, 20%C; 15-20% gravels up to ½" diam; low moisture; significant iron staining			
1			E3P2CPØ41		OVA = 0ppm
2					
3		Silty Sand as above; med brn; 25-30% gravels			
4		Silty Sand; gray brn; 70%F, 30%M Clean, dense			
5	∇				
6					
7		TD = 7'	E3P2CPØ42		OVA = 0ppm

BORING LOG GENERAL DATA

Borehole Number: ______

34

Page: 3 of ______ Signature: ______

Xerox: ______

Sent to USATHAMA: ______ Date Sent: ______

usagndat.pm4

BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Sent to USATHAMA: ______ Xerox: ______
Signature: ______ Date Sent: ______

34

Project: Sudbury - Test Pits - 9/21/93 | Boring: E3-P26-P0S | Page: 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1325 → 1355
0		Silty sand; med brn → drk brn; 40%F, 60%M; high silt content; moderate organic content			
1		Silty sand; lt brn; 20%F, 50%M, 30%C; some gravels; layers w/ high gravel content throughout; iron staining throughout.	E3P2CP0S1		OVA = 0ppm
2					
3					
4					
5					
6	∇	Gravelly sand; gray brn; 40% M, 60% C 30-40% gravels up to 1.5" diam; very few fines			
7		TD = 7'	E3P2CP0S2		OVA = 0ppm

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BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

34

Project: Sudbury - Test Pits - 9/21/93			Boring: E3-P2GPØ6		Page: 1 of 1
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 1420 → 1500
0		Sandy silt; drk brn; 70% F, 30% M high organic content; very few gravels			
		Silty sand; red brn; 40% F, 40% M, 20% C; some small gravels			
1					
2		Silty sand; lt. brn; 20% F, 40% M, 40% C; few gravels; some iron stained bands.	E3P2GPØ61		OVA = 0 ppm
3					
4		Silty sand; gray brn; 40% M, 60% C 10-20% gravels up to 1/2" diam.			
5					
6	∇		E3P2GPØ62		OVA = 0 ppm

usagndat.pm4

WATERSHED 2

Test Pits

E3-A11-P01
E3-A11-P02
E3-A11-P03
E3-A11-P04

BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

34

Project: Sudbury - Test Pits - 9/23/93			Boring: E3-A11-PØ1		Page: 1 of 1
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data 0955 → 10.33
0		Silty Sand; 20% F, 60% M, 20% C; med → drk brn; 20-25% gravels up to 1/4" diam; high organic lenses			
1		Silty Sand; 10% F; 60% M, 30% C; 20-25% gravels up to 1/4" diam; med brn; fill	E3A11PØ11		OVA = 0ppm
2					
3					
4		Leach pipe encountered			
5					
6					
7					
8					
9					
10			E3A11PØ12		OVA = 0ppm
11	▽	wet near bottom			

TD = 11'

usagndat.pm4

BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

34

Project: Sudbury - Test Pits - 9/23/93			Boring: E3-A11-PØ2		Page: 1 of 1
Depth/ Elevation (Ft.)	**USCS Symbol/ Core Sketch**	**Soil/Rock Description**	**Sample Number & Depth**	**Blow Count & Recovery**	**Drilling Data** 1100 → 1120
0		Silty Sand; med brn; 10%F, 60%M, 30%C; 20-25% gravels up to 1/4" diam; Fill			
1					
			E3A11PØ21		OVA = 0ppm
2					
3					
4					
5					
6					
7					
8		large boulder			
9		increased moisture			
10			E3A11PØ22		OVA = 0ppm

TD = 10'

usagndat.pm4

BORING LOG GENERAL DATA 34
Borehole Number: ______ Page: 3 of ______ Signature: ______ Xerox: ______ Sent to USATHAMA: ______ Date Sent: ______

Project: Sudbury - Test Pits - 9/23/93 | **Boring:** E3-A11-PØ3 | **Page:** 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
					1145 → 1215
0		silty sand; med brn → gray brn; 40% M, 60% C; 10-15% gravels throughout up to 1/8" dia			
1			E3A11PØ31		OVA = 0ppm
		iron stained layer w/ increased gravel content			
2					
3					
4	▽	organic sheen on water			
5			E3A11PØ32		OVA = 0ppm

usagndat.pm4

34 BORING LOG GENERAL DATA
Borehole Number: ______ Page: 3 of ______ Xerox: ______ Sent to USATHAMA: ______
Signature: ______ Date Sent: ______

Project: Sudbury - Test Pits - 9/23/93 | **Boring:** E3-A11-PØ4 | **Page:** 1 of 1

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
					1345 → 1420
0		silty sand; lt. brn → med. brn; 40% F, 50% M, 10% C; iron staining throughout; poorly stratified; clean; very few gravels			
1					
			E3A11PØ41 (1.5')		OVA = 0ppm
2					
3		Silty sand as above except iron staining only in thin isolated bands			
4					
5					
	▽				
6		TD = 6'	E3A11PØ42 (6')		

usagndat.pm4

APPENDIX D

GEOTECHNICAL DATA

APPENDIX D

GEOTECHNICAL DATA

This Appendix D contains summary test results of geotechnical samples collected in each watershed at the Sudbury Annex in accordance with USAEC geotechnical specifications (USATHAMA 1987). Samples submitted for geotechnical analysis were collected during sediment sampling, monitoring well installation, soil boring, and surface soil sampling. A fraction of every sediment sample was submitted for geotechnical analysis. Analysis was also performed on at least one subsurface soil sample collected at each monitoring well location. Only one borehole (E3-A12-B01) sample was submitted for geotechnical analysis. The remaining geotechnical analyses were performed on surface soil samples collected in each watershed.

All geotechnical analyses were performed by Geotesting Express, in Concord, Massachusetts. Summary tables of results were adapted from computer files provided by Geotesting Express. For each watershed, a separate table is provided for samples collected within that watershed. An additional table is provided that summarizes the geotechnical results collected from background sediment samples, Puffer Pond sediment samples, and Ministers Pond (background pond) sediment samples. Detailed laboratory reports presented to Ecology and Environment, Inc. (E & E) by Geotesting Express on 8, 18, and 29 November are on file with the E & E project manager (Geotesting Express Report Nos. 1, 2, and 3).

Geotechnical tests performed included grain size (ASTM D422) and Atterberg Limits analyses (ASTM D4318). Additionally, samples were assigned a Unified Soil Classification System (USCS) classification. It was not possible to perform Atterberg Limits analysis on all samples due to the non-plastic nature of the sample material. Samples were identified as non-plastic either by visual inspection or by a partial Atterberg Limits analyses.

The following system was followed in identifying geotechnical samples:

Character	=	1	2		3	4	5		6	7	8
Site ID	=	E	3	-	P	0	6	-	S	0	2

Character 1 = Contractor Identifier
E=Ecology & Environment, Inc.

Character 2 = Year of the Field Activity
3 = 1993

Hyphen

Character 3-5 = Site Identifier
P06 = Site P06 also used were:
BCK = Background
PUF = Puffer Pond
OFA = Ministers Pond

Hyphen

Character 6 = Sample Type
S = Surface Soil
M = monitoring well
D = sediment
B = borehole

Character 7-8 = Sample Number
Consecutive numbers for samples collected at each site.

WATERSHED 1A — UPPER TAYLOR BROOK	
P6	Puffer Pond Possible Dump Area
P16	Chemical and Waste Storage Bunkers 302, 306, and 309
P27	Pyrotechnics Test Area
P41	Bunker 303 Pesticide/Herbicide Storage
P52	Possible Drum Area near FEMA Property

Table D-1

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX — WATERSHED 1A

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Percent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI
--	SXP06021	E3-P06-S02	10.7	SM	100	14	non-plastic	non-plastic	non-plastic
--	SXP16031	E3-P16-S03	1.4	SW-SM	92	10	non-plastic	non-plastic	non-plastic
--	SXP27011	E3-P27-S01	4.7	SM	76	13	non-plastic	non-plastic	non-plastic
--	SX3801X1	E3-P38-S01	4.3	SW-SM	98	11	non-plastic	non-plastic	non-plastic
--	SXP41061	E3-P41-S06	5.3	SM	74	16	non-plastic	non-plastic	non-plastic
--	SXP52011	E3-P52-S01	6.4	SM	80	29	37.9	32.4	5.5

(a) only provided for subsurface samples.

Source: Ecology and Enviornment, Inc. 1994.

WATERSHED 1B — LOWER TAYLOR BROOK	
A2	Demolition Ground I
P11	Building T405 Area
P13	Massachusetts Fire Fighting Academy
P23	Building T465 (Drums)
P26	Air Drop Zone Clearing
P42	Offsite Dump
P45	Burned Area by Outside Fence

Table D-2

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX - WATERSHED 1B

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Per-cent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI
0-2'	BX0201X1	E3-A02-M01	7.7	SM	100	19	non-plastic	non-plastic	non-plastic
9-11'	BX0201X1	E3-A02-M01	6.8	SP	93	3	non-plastic	non-plastic	non-plastic
6-8'	BX1101X1	E3-P11-M01	24.0	CL-ML	98	88	24.3	18.7	5.6
9-11'	BX1101X1	E3-P11-M01	23.6	ML	100	66	non-plastic	non-plastic	non-plastic
--	DX1101X1	E3-P11-D01	48.9	SM	96	30	76.5	54.3	22.3
--	DX1102X1	E3-P11-D02	141.2	SM	100	50	156.9	118.6	38.4
--	DXP11031	E3-P11-D03	21.5	SP	87	1	non-plastic	non-plastic	non-plastic
14-16'	BX1301X1	E3-P13-M01	28.1	SP-SM	100	9	non-plastic	non-plastic	non-plastic
19-21'	BX1301X1	E3-P13-M01	23.6	SP-SM	100	9	non-plastic	non-plastic	non-plastic
4-6'	BX1302X1	E3-P13-M02	16.3	SP	84	4	non-plastic	non-plastic	non-plastic
14-16'	BX1302X1	E3-P13-M02	23.7	SP-SM	99	7	non-plastic	non-plastic	non-plastic
4-6'	BX1303X1	E3-P13-M03	16.4	SP	99	4	non-plastic	non-plastic	non-plastic
14-16'	BX1303X1	E3-P13-M03	28.9	ML	100	56	non-plastic	non-plastic	non-plastic
9-11'	BX1304X1	E3-P13-M04	20.0	ML	97	53	20.9	19.4	1.5
--	DX1301X1	E3-P13-D01	1595.9	OH	100	85	423.5	301.4	122.1
--	DX1302X1	E3-P13-D02	3.8	SP	96	4	non-plastic	non-plastic	non-plastic
--	DX1303X1	E3-P13-D03	35.2	SW-SM	97	10	non-plastic	non-plastic	non-plastic
--	DX1304X1	E3-P13-D04	72.2	SP-SM	94	6	non-plastic	non-plastic	non-plastic
--	DX1305X1	E3-P13-D05	40.4	SP-SM	100	9	non-plastic	non-plastic	non-plastic

(a) only provided for subsurface samples

Source: Ecology and Environment, Inc. 1994.

WATERSHED 2 — HOP BROOK	
A10	Railroad Pit/UST Area
A11	Leaching Field
A12	PCB Spill; Remediation Area
P28	Rocket Range
P36	Former Raytheon Building T104
P37	Building T106 UST
P38	Former Railroad Inspection Pit
P39	Dump Area

Table D-3

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX - WATERSHED 2

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Percent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, PL	Plastic Limit, PL	Plasticity Index, PI
9-11'	BX1001X1	E3-A10-M01	8.7	SP	76	3	non-plastic	non-plastic	non-plastic
--	SXA10021	E3-A10-S02	8.6	SM	98	18	non-plastic	non-plastic	non-plastic
--	DX1001X1	E3-A10-D01	113.3	SP-SM	79	5	75.5	75.4	0.1
--	DX1002X1	E3-A10-D02	506.7	SM	99	36	496.0	376.0	120.1
--	DXA11011	E3-A11-D01	18.8	SP	72	1	non-plastic	non-plastic	non-plastic
--	DXA11021	E3-A11-D02	44.4	SW-SM	100	10	non-plastic	non-plastic	non-plastic
--	BX120101	E3-A12-B01	6.9	SM	96	16	non-plastic	non-plastic	non-plastic
--	SX2801X1	E3-P28-S01	3.2	SP	96	5	non-plastic	non-plastic	non-plastic
9-11'	BX3601X1	E3-P36-M01	10.0	SM	94	34	13.9	12.5	1.5
9-11'	BX3602X1	E3-P36-M02	11.8	SM	97	34	non-plastic	non-plastic	non-plastic
14-16'	BX3603X1	E3-P36-M03	9.2	SM	81	19	non-plastic	non-plastic	non-plastic
--	SX3601X1	E3-P36-S01	1.1	SW-SM	91	10	non-plastic	non-plastic	non-plastic
14-16'	BX3701X1	E3-P37-M01	10.1	SM	90	25	non-plastic	non-plastic	non-plastic
14-16'	BX3702X1	E3-P37-M02	20.9	ML	99	59	non-plastic	non-plastic	non-plastic
14-16'	BX3703X1	E3-P37-M03	20.7	SP-SM	100	11	non-plastic	non-plastic	non-plastic
--	SX3703X1	E3-P37-S03	6.6	SM	98	12	non-plastic	non-plastic	non-plastic
--	DXP37011	E3-P37-D01	250.2	SM	99	14	non-plastic	non-plastic	non-plastic
--	DXP37021	E3-P37-D02	23.2	SP	62	1	non-plastic	non-plastic	non-plastic
--	DXP37031	E3-P37-D03	770.4	SM	92	38	non-plastic	non-plastic	non-plastic
--	SX3801X1	E3-P38-S01	4.3	SW-SM	98	11	non-plastic	non-plastic	non-plastic
--	DX3901X1	E3-P39-D01	450.5	SP-SM	97	9	61.6	49.7	11.9
--	DX3902X1	E3-P39-D02	383.4	SW-SM	88	9	392.7	342.1	50.6
--	DX3903X1	E3-P39-D03	350.3	SW-SM	81	9	487.4	405.2	82.3
--	DX3904X1	E3-P39-D04	365.6	SM	100	14	409.6	285.8	123.8
--	DX3905X1	E3-P39-D05	425.5	SM	100	14	516.6	369.8	146.8
--	DX3906X1	E3-P39-D06	363.9	SP	100	4	non-plastic	non-plastic	non-plastic

(a) only provided for subsurface samples.

Source: Ecology and Environment, Inc. 1994.

WATERSHED 3 — LOWER ASSABET RIVER	
P9	Stream Dump Area between Areas A7 and A9
P57	Former Building S449

Table D-4

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX - WATERSHED 3

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Percent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI
--	SXP09021	E3-P09-S02	11.4	SM	92	22	36.9	30.8	6.0
9-11'	BX5701X1	E3-P57-M01	10.8	SP-SM	74	9	non-plastic	non-plastic	non-plastic
--	DXP57011	E3-P57-D01	154.9	OH	100	83	194.4	135.5	58.9
--	SX5703X1	E3-P57-S03	15.0	SM	100	26	41.0	32.5	8.4

(a) only provided for subsurface samples.

Source: Ecology and Environment, Inc. 1994.

WATERSHED 4 — UPPER ASSABET RIVER	
A6	Demolition Ground II
P22	Old Gravel Pit

Table D-5

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX — WATERSHED 4

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Percent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI
13.5-15.5'	BX0601X1	E3-A06-M01	22.6	SM	99	21	non-plastic	non-plastic	non-plastic
--	SXA06011	E3-A06-S01	17.7	SW-SM	88	11	non-plastic	non-plastic	non-plastic
--	DXA06011	E3-A06-D01	83.0	SM	99	24	non-plastic	non-plastic	non-plastic
--	DXA06021	E3-A06-D02	32.5	SM	99	37	25.2	22.5	2.6
4-6'	BX2201X1	E3-P22-M01	22.7	SP-SM	100	9	non-plastic	non-plastic	non-plastic
14-16'	BX2201X1	E3-P22-M01	24.5	SP	100	2	non-plastic	non-plastic	non-plastic
--	SXP22021	E3-P22-S02	3.6	SW-SM	88	8	non-plastic	non-plastic	non-plastic

(a) only provided for subsurface samples

Source: Ecology and Environment, Inc. 1994.

WATERSHED 5 — LAKE BOON	
A5	Solvent Waste Dump
P31/P58	Old Dump and Sudbury Road Dump

Table D-6

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX — WATERSHED 5

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Percent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI
49-51'	BX0501X1	E3-A05-M01	26.7	ML	100	93	non-plastic	non-plastic	non-plastic
9-11'	BX0501X1	E3-A05-M01	18.9	SP	98	2	non-plastic	non-plastic	non-plastic
--	DXA05011	E3-A05-D01	786.1	SM	100	35	non-plastic	non-plastic	non-plastic
9-11'	BX3101X1	E3-P31-M01	30.7	SP	97	4	non-plastic	non-plastic	non-plastic
14-16'	BX5802X1	E3-P56-M02	28.7	SP	100	2	non-plastic	non-plastic	non-plastic
4-6'	BX5801X1	E3-P58-M01	28.4	SM	99	12	26.7	22.9	3.8
44-46'	BX5801X1	E3-P58-M01	24.5	ML	100	57	non-plastic	non-plastic	non-plastic
4-6'	BX5802X1	E3-P58-M02	9.9	SW-SM	90	8	non-plastic	non-plastic	non-plastic
--	SXP58011	E3-P58-S01	41.3	SM	95	23	56.9	49.2	7.7
--	DXP58011	E3-P58-D01	425.4	ML	96	57	non-plastic	non-plastic	non-plastic
--	DXP58021	E3-P58-D02	5.1	SP	91	4	non-plastic	non-plastic	non-plastic

(a) only provided for surface samples.

Source: Ecology and Environment, Inc. 1994.

11:UC6010-1/RC1134_V3_03/15/94-D1

WATERSHED 6 — WILLIS POND AND CRYSTAL LAKE	
P2	Building T267 Fuel Spills
P3	P3 Building T209 UST

Table D-5

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX — WATERSHED 4

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Percent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI
13.5-15.5'	BX0601X1	E3-A06-M01	22.6	SM	99	21	non-plastic	non-plastic	non-plastic
--	SXA06011	E3-A06-S01	17.7	SW-SM	88	11	non-plastic	non-plastic	non-plastic
--	DXA06011	E3-A06-D01	83.0	SM	99	24	non-plastic	non-plastic	non-plastic
--	DXA06021	E3-A06-D02	32.5	SM	99	37	25.2	22.5	2.6
4-6'	BX2201X1	E3-P22-M01	22.7	SP-SM	100	9	non-plastic	non-plastic	non-plastic
14-16'	BX2201X1	E3-P22-M01	24.5	SP	100	2	non-plastic	non-plastic	non-plastic
--	SXP22021	E3-P22-S02	3.6	SW-SM	88	8	non-plastic	non-plastic	non-plastic

(a) only provided for subsurface samples

Source: Ecology and Environment, Inc. 1994.

ADDITIONAL GEOTECHNICAL RESULTS

Background Samples
Puffer Pond
Ministers Pond (background pond)

Table D-8

SUMMARY OF GEOTECHNICAL TEST RESULTS
SUDBURY TRAINING ANNEX - OTHER

Sample Depth (a)	Sample ID	Site ID	Moisture Content, Percent	Classification	Percent Passing #4	Percent Passing #200	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index, PI
--	DXBCK011	E3-BCK-D01	23.0	SP	98	1	non-plastic	non-plastic	non-plastic
--	DXBCK031	E3-BCK-D03	19.5	SP-SM	78	7	non-plastic	non-plastic	non-plastic
--	DXBCK041	E3-BCK-D04	17.2	ML	91	55	non-plastic	non-plastic	non-plastic
--	DXBCK081	E3-BCK-D08	26.5	SP	83	2	non-plastic	non-plastic	non-plastic
--	DXBCK021	E3-BCK-D02	31.2	SW-SM	92	6	non-plastic	non-plastic	non-plastic
--	DXBCK051	E3-BCK-D05	234.7	OH	92	56	157.9	128.0	29.8
--	DXPUF011	E3-PUF-D01	148.9	SP-SM	100	12	56.8	53.1	3.6
--	DXPOF021	E3-PUF-D02	765.9	OH	100	87	429.1	243.8	185.4
--	DXPOF031	E3-PUF-D03	946.5	OH	100	88	476.1	288.7	187.4
--	DXPOF041	E3-PUF-D04	913.4	OH	100	97	513.9	281.6	232.3
--	DXPOF051	E3-PUF-D05	699.8	SM	100	42	non-plastic	non-plastic	non-plastic
--	DXPOF061	E3-PUF-D06	923.4	OH	100	84	501.5	287.7	213.7
--	DXOFA011	E3-OFA-D01	767.1	OH	100	84	361.9	217.5	144.3
--	DXOFA021	E3-OFA-D02	1151.8	OH	100	84	513.1	281.6	231.5
--	DXOFA031	E3-OFA-D03	1098.6	OH	100	93	479.7	267.6	212.1
--	DXOFA041	E3-OFA-D04	1208.9	OH	100	91	509.7	290.7	219.0
--	DXOFA051	E3-OFA-D05	1071.8	OH	100	86	460.1	298.3	161.8
--	DXOFA061	E3-OFA-D06	1149.2	OH	100	96	489.1	289.3	199.8

(a) only provided for subsurface samples.

Source: Ecology and Environment, Inc. 1994.

APPENDIX E

GEOPHYSICAL SURVEYS

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APPENDIX E

GEOPHYSICAL SURVEYS

E.1 INTRODUCTION

This Appendix E contains reports describing the methods and results of the geophysical surveys conducted at the Sudbury Training Annex (the Annex) in Middlesex County, Massachusetts. This work was performed by E & E as part of an investigation for the United States Army Environmental Center (USAEC) from April to November of 1993. Survey methods, targets, and goals varied according to the specific needs of each site. Exploration targets included mapping of subsurface geology (bedrock and groundwater table), buried metallic objects, pipelines or leach fields, and suspected dump sites containing metallic and non-metallic wastes.

Geophysical work was performed at 13 individual sites. However, at some sites, adjacent sites were combined into a single geophysical survey because exploration targets were common to the combined sites. The following geophysical methods were used at the Annex:

- **Seismic Refraction (SR):** Conducted surveys at P11/P13 and P36/P37.
- **Electromagnetic Conductivity (EM):** Conducted surveys at P56, P13, P36/P37, P39, A8/P10, P40 and P58.
- **Magnetometry (MAG):** Conducted surveys at P13, P39 and P22.
- **Ground Penetrating Radar (GPR):** Conducted surveys at A1 and A11.

The SR survey was performed 20-26 May 1993, and all EM, MAG, and GPR work was performed 2-13 August 1993.

The survey team searched the draft OHM report to gather information and existing data on previous geophysical surveys at relevant sites. In many cases, this background search eliminated redundant data collection. The results of this background data search are discussed with the results from site surveys in Section 3 of this report.

E.2 METHODOLOGIES

The selection of the geophysical method to be used at a specific site is a result of the exploration target and the anticipated response of an instrument to that target. Often, multiple methods are chosen when combined data can enhance the definition of an exploration target.

All geophysical survey methods comprise three phases: data acquisition, data reduction, and interpretation. For example, operation of a metal detector can be considered as using all three phases though the phases occur almost simultaneously in the operator's mind. Data acquisition and data reduction methods for the different instruments used in this geophysical survey will be discussed in the following subsections. Interpretation methods will be discussed in both this section and Section 3 to facilitate description of the geophysical survey. Appropriate field or processed data from the different geophysical methods used at each site are included as attachments following Section 3.

E.2.1 Seismic Refraction Surveys

The seismic method for subsurface exploration works by measuring seismic or sound waves as they are reflected off materials of different densities. The physics of wave propagation provides a standard by which material density can be determined.

The components for acquiring seismic data are:

1. SHOT — This is the energy source that generates seismic, or acoustic waves, to propagate through the subsurface.

2. RECEIVER — This instrument converts ground motion caused by the seismic waves into an electrical signal.

3. RECORDER — This electrical instrument converts and stores the signals from the receiver into positive or negative integers of varying amplitudes that correlate with the ground motion intensity and direction (up or down) at that receiver. After the shot is generated, the recorder continuously samples each receiver at a discrete time interval until a user specified total time is reached.

The interpretation of seismic data involves the reduction of differential travel times to an event, to determine the velocities of the material through which the energy is traveling. Using true velocities (in feet or meters per second) and the time delay (in milliseconds), depth can be calculated. The depths calculated can then be subtracted from the shot site elevations, plotted on a base map, and the horizon of interest contoured.

An ABEM MINILOC seismograph was used to collect the seismic data. Three, 36-trace records were generated in a somewhat unique way for each seismic line as follows:

Three geophones were "planted" on the seismic line — one at each end with the third in the middle. Then, 36 shot points were spaced evenly between the two end geophones, with each shot recorded as a single trace in each of the three geophone records. Shot energy was created by using a 12-pound sledge hammer to strike a rubberized-plastic plate. Three to five shots were "stacked" at each shotpoint location. After all shots were made, the geophysicists examined the resultant data and stored satisfactory data on a laptop computer.

Field interpretation was done on select lines of data. The last data line of the day and the first data line of a new area were usually selected. The geophysicists verified acquisition parameters by using the MINILOC's built-in software.

They then performed final interpretation using SeisREFA, a software package from OYO Corporation. The following procedures were implemented to process the data from raw records to final contour maps. To reduce ambiguity, steps 2-5 were often performed several times.

DATA REDUCTION PROCEDURES

1. Convert the MINILOC raw data to a format compatible with SeisREFA by entering the data into the computer.

2. Pick the seismic first breaks interactively on the computer.

3. Determine the number of layers, and their velocities, from the first breaks, time-distance graph.

4. Generate an initial geologic model, using the layers and velocities given, by applying SeisREFA.

5. Interactively edit the model to get a best fit of model response to the time-distance graph.

6. Convert model layer depths from meters to feet.

7. Plot layer depths from all seismic lines onto a base map and contour.

The contour maps created during this survey are displayed and discussed in Section 3 of this report. Section 3 also has a data packet for each site surveyed including:

- Raw records showing the three seismic records for each line.

- Model Profiles. Lower portions show final models with layer velocities (in kilometers per second) and seismic raypaths. Upper

portions show the first-break, time-distance graph (circles connected by solid lines), with the model response superimposed (dotted lines).

E.2.2 Electromagnetic Conductivity Surveys

The instrument used for this geophysical method was the Geonics EM31 Terrain Conductivity Meter. This meter continuously measures the apparent terrain conductivity of materials beneath and immediately surrounding it. The EM31 consists of a small control box with two opposing booms extending approximately 5-1/2 feet from the box. At the end of one boom is a transmitter coil, with a receiver coil at the end of the other boom. The coils are fixed in parallel planes with the EM31 booms perpendicular to each plane. The depth of investigation achieved by the EM31 at the Annex sites was approximately 18 feet for the vertical dipole and 9 feet for the horizontal dipole. The different dipoles are applied by rotating the EM31 90 degrees about the axis through the booms.

Two general conditions can occur in the subsurface that affect the type of data observed from the EM31. Where subsurface conditions are horizontally homogenous, all readings, as the operator turns to orient the boom in different directions, should be equal, or isotropic. However, where non-homogenous conditions occur, non-isotropic readings will be observed. For example, if an operator is directly over a buried pipe, with the instrument booms perpendicular to this pipe, then a reading less than zero (<0) may be observed. This is due to the highly conductive pipe short-circuiting the induced subsurface current between transmitter and receiver. If the operator turns 90 degrees making the booms parallel with the pipe, the readings should then be much higher than those of the background terrain.

Two basic EM survey methods were used at the Annex; a gridded survey and a reconnaissance survey. During a gridded survey, data is collected and recorded at stations that have been established by some form of land survey method. Site P13 was the only site where an EM gridded survey was performed. Data reduction and analysis are presented in the P13 site results section (Section 3.2.2.2).

An EM reconnaissance survey can be considered as one that acquires data for real-time analysis, because the operator continuously watches the EM31 meter for any readings that deviate from background levels. In this type of survey the results are usually recorded but not the data. For example, a pipeline may be located by walking back and forth with an EM31 over a few locations and flagging the pipeline at each location. This type of survey is usually not conducive to locating more subtle anomalies, but is very cost effective when the exploration targets are large or shallow, highly conductive objects such as USTs or pipes.

All conductivity readings from the EM31 are in millimhos per meter (mmhos/m).

E.2.3 Magnetrometry Surveys

Operators also used an EG&G G856 proton precession magnetometer during the Annex survey. This instrument provides readings that are a measurement of the total Earth's magnetic field, expressed in gammas. The presence of ferrous metals will cause anomalous readings from the local background reading, allowing operators to identify and map the presence of metal objects.

The first step in a MAG survey is to establish stations (usually on a grid) where readings will be taken. A base station is established at a background location and an initial reading taken. Station readings are then taken and recorded, along with the station location, with a final base station reading taken at the end of the day, or at survey completion. The operator periodically returns to the base station to record a new reading and the time it was taken. These base station readings are used to check against an ongoing magnetic storm or are used to correct the survey data for diurnal variations. Any observable metal in the survey area should be logged and located so any correlation with magnetic anomalies can be determined later.

Data reduction begins with correction for diurnal variations. The base station readings are adjusted to a baseline value and these adjustments are interpolated and applied to the intervening data readings. There are times when this step may be skipped because the exploration target yields anomalies much greater than the diurnal variations. This data (corrected, or uncorrected) is then posted on a base map and contoured.

There are two types of anomalies that may be seen on a magnetic data contour map — a dipole anomaly or a monopole anomaly. Most ferrous metal objects in the northern hemisphere exhibit a dipole anomaly where the southern portion of the object would cause readings greater than background (positive pole), with the negative pole expressed at the northern end. Where the vertical axis of an object is much greater than the horizontal, a monopole anomaly occurs. This is due to the negative pole being masked by the positive pole, which is above it and closer to the instrument.

E.2.4 Ground Penetrating Radar

Survey operators used a GSSI Model SIR-3 GPR unit with 500 Mhz and 900 Mhz antennas available to complete investigations at the Annex.

The GPR method involves transmission of an energy pulse into the subsurface by the unit's antenna. The pulse is then partially reflected back to the antenna's receiver after interfacing with materials having differing electrical properties. The velocity of a pulse through a material is the distance it travels in that material divided by the time needed to travel that distance. This is analogous to the seismic method in that the instrument records the time delays between the energy transmission and when reflections of that energy arrive at

the receiver. The SIR-3 processes this data through gains and filters and displays it on a graphical recorder.

Figure 2-1 shows a GPR record shot over a known pipeline that crosses the Annex. This was done to calibrate instrument settings for the region and use the pipe depth for correlation to a site's data. As the GPR antenna approaches a spherical surface, such as a pipeline running perpendicular to the direction of antenna travel, reflections from that surface return along a path at an acute angle to the vertical. This angle, and the time required for reflections traveling along that path, decrease until the antenna is directly over the reflecting surface. The delay time and angle then increase again as the antenna proceeds along the survey line. Since reflections are plotted on the graphic recorder directly below the current antenna location, a parabolic feature is observed.

The pipeline in Figure 2-1 is located within the top of the parabolic reflector. A known depth to this pipeline could not be obtained from the pipeline owner, although a company representative said 2 to 4 feet was the normal pipeline depth. A procedure was used that evaluates the geometry of the parabola to yield qualitative values for its depth and the velocity of the overlying materials. Using this method, an approximate depth to this pipe of 6.3 feet and an approximate average velocity of 2.0 nanoseconds/foot for the overlying materials were calculated. This velocity appears a little too fast for most near-surface materials found at the Annex. By using a velocity between 2.5 and 3.0 nanoseconds/foot, depending on the surface material at a GPR line, reliable estimates within one to two feet should be realized. (Note: A quantitative approach requires the determination of more exact subsurface velocities, with significantly greater data acquisition and processing times.)

To collect GPR data, operators first selected a line location and staked line endpoints. The ground surface was then cleared to allow for the smooth travel of the antenna along the line. Fiberglass tape was laid out along the line with zero marked at one end. The antenna was then placed just beyond the beginning of the line and connected to the nearby GPR recorder. The recorder was turned on and the antenna was slowly pulled along the line at a nearly constant speed. As the center of the antenna passed the tape zero, and at specified intervals, a button was pushed that caused a location marker to be plotted on the graphic display.

Data reduction and interpretation can vary depending on the exploration target. The procedures used for specific sites will be discussed in the results section (Section 3).

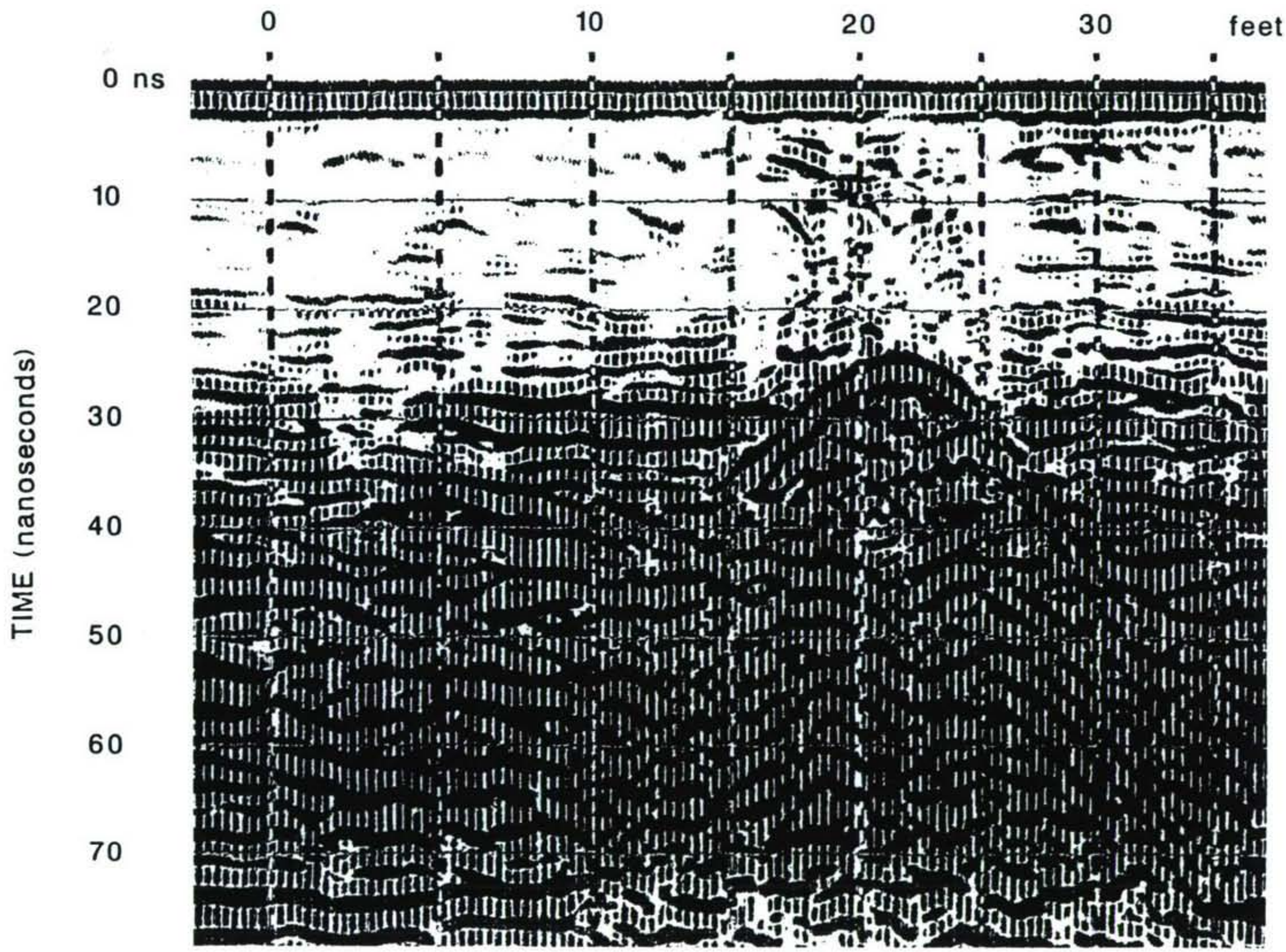

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Figure 2-1: GPR TEST PROFILE OVER KNOWN PIPELINE

E.3 GEOPHYSICAL SURVEY RESULTS

The results for all geophysical work at the Annex are grouped below by watershed and site. Geophysical data discussed and referenced in this section can be found in the attachments following this section, grouped by sites in the order in which they were addressed. In Figures, some of the sites may be referred to as Study Areas. For this Appendix, the terms will be used interchangeably.

E.3.1 Watershed 1A — Upper Taylor Brook

E.3.1.1 Site P56

This site is a series of clearings east of Bunker 313. A data search of the draft OHM report indicated that no geophysical survey was previously done in this area. The geophysical team found a heavily overgrown access road to the P56 clearing 175 feet southwest of Bunker 314. The geophysical team ran a survey traverse, using a compass and fiberglass tape, from an extension of the centerline of the main asphalt road, into Site P56, circumventing the series of clearings (Figure 3-1). They then set wooden stakes at the traverse turning points (TP1 to TP5) to allow for location of any geophysical anomalies and subsequent investigation activities. An EM reconnaissance survey was performed throughout this series of clearings. Most of the survey was done by slowly walking with the EM31, both along the traverse legs and parallel to them at offsets of approximately 10 feet. The operator also walked the edges of the clearings and performed spot checks to insure that the clearings were entirely surveyed. Background readings measured between 3.5 to 4.0 mmhos/m. No anomalous areas were found, with all readings falling between 3.0 to 4.5 mmhos/m.

E.3.2 Watershed 1B — Lower Taylor Brook

E.3.2.1 Site A1

This site is a clearing in the northern portion of the Annex. The exploration target was an excavated area that may have been used to dispose of decontaminated, plastic-bagged clothes used in mustard agent tests. A background search of the OHM report provided an EM reconnaissance survey contour map and a base map showing the location of OHM's GPR lines. The actual GPR profiles were not available. Because earlier EM data was inconclusive, and OHM concentrated their GPR investigation on the central portion of the clearing, the E & E team decided to collect additional GPR data to more completely cover the A1 site. Figure 3-2 shows the location of GPR lines from both the E & E and GPR surveys and the OHM test pit location "A". OHM dug four other test pits at "unlabeled GPR anomalies"; however, their exact locations are not known, and no previously excavated areas were found. Analysis of the GPR profiles indicated possible large areas of disturbed soil, generally fairly shallow (less than 1 to 2 feet). However, a set of these profiles shows a more distinct disturbance that could be correlated and mapped over six of the GPR lines. Figure 3-2 shows this disturbed area as shading across the southeasterly portion of the site. This

shading depicts a possible trench-like structure that is deeper at one end (heaviest shading). Figures 3-3 and 3-4 show portions of GPR lines 4 and 9. At the intersection of these lines the disturbed area may be up to 6 or 7 feet deep, and appears to be fairly steep-walled on three sides. The fourth side appears to have a gradual incline from the northwest, as shown on GPR-9 (Figure 3-4). All depths are approximate since true subsurface velocities could not be determined. The GPR profiles for all lines in Site A1 can be found in Attachment A. Breaks in the data profiles are due to momentary stoppages of the GPR graphic recorder. Where these stoppages were insignificant, lines were not resurveyed. The problem was corrected after tightening a loose connector part-way through the survey.

E.3.2.2 Site P11/P13

Seismic Survey

The E & E team shot eight seismic lines at Sites P11 and P13 for a total of 2,658 linear feet. Data quality was good to excellent for most data. Three-layer models were used in the data reduction, with velocities throughout the sites fairly constant. The upper layer of the model represents the unsaturated overburden, with velocities averaging 1,190 feet per second. The model's middle layer detailed saturated overburden and averaged about 5,100 feet per second, and the model's deepest layer, or bedrock, averaged about 14,000 feet per second.

Figure 3-5 shows bedrock contours, as derived from seismic depth calculations. Figure 3-6 shows the contours for the top of the middle layer (approximate water table). It is important to note that these contour elevations are accurate in a relative rather than an absolute sense. This is because a single velocity was used for a layer across the whole seismic line because of a limitation in the data reduction procedure and software. Often, minor lateral changes in geology also mean minor velocity changes, which can cause slightly inaccurate depth determinations of up to 1 or 2 feet in Figure 3-5. These inaccuracies would not result in any major change in the overall bedrock surface. However, in Figure 3-6, the groundwater contours are more susceptible to these minor variations. Nevertheless, the relative highs and lows are the most significant information, and their locations would not be affected.

The bedrock contours in Figure 3-5 indicate a somewhat undulating surface in the western portion of the survey. A bedrock high appears to run along the southeasterly edge of the site, with a trough, or basinal feature, extending from the center of the site to the north. A groundwater high (Figure 3-6) is located over this trough, or bedrock low. Drainage from this high appears to be to the north, northwest, and the west-southwest. Some drainage probably also occurs to the southeast, although that is not evident in the groundwater contours. Seismic line SSL-8 indicates that the water table comes up at the drainage canal just south of P11 and P13 implying that this is a losing stream.

The seismic data can be found in Attachment B, following this report. For each line, this consists of the three seismic records and the time-distance graph with the model profile.

EM/MAG Survey

Operators performed a gridded EM conductivity and magnetometer survey at Site P13 with data collected on 20-foot spacings and an EM reconnaissance survey around Buildings 406, 407, and 462. Figure 3-7 shows the site with grid node locations and the inferred septic system and leach field indicated by the dashed lines. The location of the system was deduced from the geophysical data as well as from an old drawing of the P13 sewer system, although pipe locations from Building 406 are slightly different from those indicated on the drawing. EM data was collected by taking readings with the boom first oriented along the grid north-south and then in the east-west direction. Operators took vertical and horizontal dipole readings for a total of four readings at each grid node. A single total magnetic field reading was also taken at each node. The EM data was analyzed by calculating the difference between the N-S and E-W readings. The shaded areas of Figures 3-8 and 3-9 outline where this difference was greater than 0.1 mmhos/m, and the arrows at the enclosed grid nodes indicate non-isotropic readings, with the direction of the arrow indicating the highest reading. By blocking off and shading the areas of non-isotropic readings, it was hoped that a pattern would emerge locating the leach field pipes.

Contours of isotropic data were not generated due to EM31 background readings before and after lunch differing by about 3.0 mmhos/m. The probable cause may have been activities at the USAF radar station approximately 2,000 feet west-southwest of the site. A qualitative analysis of the isotropic readings showed no anomalies in homogenous terrain conductivity. Non-isotropic readings evaluation, and the magnetometry survey, were not affected by this interference.

The magnetometer data was reduced by applying diurnal corrections to it, plotting the corrected readings, then contouring the data (Figure 3-10). Diurnal corrections were determined from base station readings taken about every half-hour.

Figure 3-7 also shows anomalies identified. Location "A" is a possible manhole, or cleanout to the septic system, located at grid coordinates N 2+75, E 1+69. This location was observed in the field as a slight depression, as if it had been opened up and surface soil had washed into it. An EM reconnaissance directly over this location yielded locally anomalous readings. Location "B" is a well defined magnetic anomaly (Figure 3-10) of moderate strength. Location "C" appears to be a good area to look for the leach field pipes, as determined from the EM data. A trench-like pit perpendicular to the pipe length would be the best exploration method. Location "D" was chosen from the magnetic data, along with the results from the EM reconnaissance survey around building 406. A test pit from the corner of the building addition towards grid coordinates N2+80, e1.00 might be the best approach.

E.3.3 Watershed 2 — Hop Brook

E.3.3.1 Site A11

Operators performed two separate GPR surveys at the A11 site in two different portions of A11, called the northern and southern surveys in this report. In the northern area survey, operators can run GPR lines between very small structures, or between the residual concrete pads of decayed structures. The primary exploration target was buried septic system components. Although lengths of sewer pipe were found on the ground surface, no indication of buried pipes or any other structures, was observed in the GPR profiles. The southern survey area was located in a clearing that appeared to be mostly loose sand fill. Figure 3-11 shows the locations of all GPR lines within this area and points out anomaly locations. GPR profiles 12, 17, and 18 showed parabolic reflections indicative of buried pipes. This is particularly true for line 17, which shows five distinct parabolic reflectors evenly spaced between the 0 to 5 foot mark. Estimated depth of these inferred pipes is 3 to 4 feet. Line 12 shows a reflector increasing in depth from the 40- to the 53-foot mark. This could indicate an excavation or the original grade below the sand fill. At the 57.5-foot mark is a strong reflection, slightly parabolic, but more massive and wider than what would be expected from a pipe. This could be a boulder or any similar object. Beneath this reflector are some faint parabolic reflections that may indicate the presence of buried pipes, at estimated depths between 4 to 5 feet deep. GPR profiles for all lines shot (north and south survey areas) can be found in Attachment D.

E.3.3.2 Site P36/P37

Seismic Survey

Nine seismic lines were shot at Site P36/P37, for a total of 2,838 linear feet. Data quality was fair to good for most of the data, although the pine needle fluff in forested areas had to be removed at geophone and shot locations to ensure good contact with the ground. Three-layer models were used in the data reduction for most lines, with velocities throughout the site fairly constant. The model's upper layer represented the unsaturated overburden, with velocities averaging 1,200 feet per second. The model's middle layer detailed saturated overburden averaging about 5,100 feet per second. The model's deepest layer, or bedrock, averaged about 13,200 feet per second. Seismic line SSL-14 did not exhibit the same data quality, layer distinctiveness, or velocities as the rest of the survey. The seismic records were of very poor quality, and all attempts to produce a model profile that correlated with the time-distance graph were unsatisfactory. Therefore, the data from this line was not used to generate the contour maps in the final interpretation.

Figure 3-12 shows the bedrock contours as derived from seismic depth calculations. Figure 3-13 shows the contours for the top of the middle layer (approximate water table). It is important to note that these contour elevations are accurate in a relative rather than an absolute sense because a single velocity was used for a layer across the whole seismic line,

because of a limitation in the data reduction procedure and software. Often, minor lateral changes in geology also mean minor velocity changes, which can cause slightly inaccurate depth determinations, as much as 1 to 2 feet. Because both maps were drawn with 10-foot contour intervals, these inaccuracies would result in little difference in the overall spatial attitude of the contours.

In general, the bedrock contours shown in Figure 3-12 indicate that this surface is sub-parallel with the ground surface. That is, the bedrock highs are found beneath topographic highs, and dip towards the valleys. However, one exception exists in the northwest portion of the site where the bedrock deepens to the northwest while the topography remains fairly flat. The apparent groundwater contours shown on Figure 3-13 also exhibit this sub-parallel attitude, although in the northwestern portion of the survey the water table also appears to remain fairly flat following the topography.

This seismic data can be found at the end of Attachment E, following this report. Three seismic records and a time-distance graph with model profile detail each seismic line.

EM Reconnaissance Survey

An EM reconnaissance survey was performed around and between the buildings at Site P36/P37 and found large amounts of metal on the ground near the buildings. This debris, and the two metal buildings caused a great deal of interference that masked anomalous readings from subsurface objects. Using the EM31, the reconnaissance survey team did find an apparent buried pipe running between the two buildings. This inferred pipe appeared to be laid behind the P36 building where it extended above ground towards a concrete pad containing a vertical pipe. This pad was located about 40 feet south of the center of the P37 building.

E.3.3.3 Site P39

This site is mostly wetlands that are seasonally submerged and the E & E geophysical team found very little standing water at the site during its visit. A data search of the draft OHM report yielded EM terrain conductivity and magnetometry contour maps, and the OHM data was collected on a gridded survey. The E & E team first walked the OHM grid to correlate the EM and MAG anomalies with surface debris. With one exception, all these anomalies were found to be in areas of surfacial or partially buried metallic objects. However, one small anomaly on the south edge of the grid could not be accounted for by any observable metal or debris. This anomaly was approximately centered at grid coordinates N 0+10, E 2+40.

Figure 3-14 shows a portion of the OHM grid and an extension of this grid laid out by the E & E geophysical team. The team collected magnetometer data at the grid nodes shown and performed an EM reconnaissance over the area. Because base station readings,

taken at N 0+10, E 2+80, varied only by 2.5 gammas, diurnal corrections were not applied to the data.

The small anomaly previously mentioned in the OHM data is not evident in the MAG data shown in Figure 3-14. A possible explanation is that the anomaly was caused by surface metal that has been moved since the OHM survey. All other magnetic anomalies could be accounted for by surface debris. The EM reconnaissance found two locations where fairly small conductivity objects are possibly buried. These locations are shown in Figure 3-14 with symbols indicating their non-isotropic EM readings.

Background total magnetic field readings were about 400 gammas higher than those found in other sites at the Annex. This is probably due to natural causes such as a change in bedrock type with an increase in ferromagnetic minerals.

E.3.4 Watershed 3 — Assabet River (North)

E.3.4.1 Site A8/P10

An EM reconnaissance survey was performed at two test pit locations previously staked by OHM as test pits "I" and "J". The exploration targets were metallic debris or objects in the subsurface. The team found anomalous readings at each of these locations indicating that the stakes had not been moved since the previous investigation. The anomaly at location "J" was centered 1 to 2 feet south of the stake, with all readings moderately elevated (5 to 12 mmhos/m above background), indicating the presence of dispersed debris. In contrast, the readings at location "I" were less than zero at the stake, with the highest readings (10 to 25 mmhos/m above background) 6 to 8 feet from the stake, indicating a single, large, metallic object.

E.3.5 Watershed 4 — Assabet River (Northwest)

E.3.5.1 Site P22

This site is a large borrow pit of sandy material. A magnetometry survey was performed to determine if buried metallic objects exist at this site, which would indicate possible dumping. Surfacial debris, primarily of a household nature, was scattered throughout the area. The locations of metallic debris were mapped in the field and are shown as shaded areas on Figure 3-15.

The magnetometer data was corrected for diurnal variations using a baseline of 54,600 gammas. Base station readings were taken every 20 to 30 minutes at grid location N 1+00, E 2+00. Analysis of the data shows a gradual increase in background readings totalling about 40 gammas from southeast to northwest. This is most likely due to natural subsurface conditions. All magnetic anomalies correlate well with metallic debris on the

surface. This indicates that there is no substantial metal in the subsurface, although minor amounts may exist beneath the surface debris areas.

The raw magnetometer data is included in Attachment F following this report.

E.3.6 Watershed 5 — Boons Pond (Assabet River)

E.3.6.1 Site P40

An EM reconnaissance survey was performed throughout the cleared area surrounding a house (building T452) at the P40 site, which is bounded by Patrol Road and White Pond Road (Figure 3-16). An apparent cistern was located 35 feet southeast of Building T452. The team located a circular concrete slab, 4.4 feet in diameter, with a metal ringed hole in the center 35 feet southeast of Building T452. The possible cistern was visible and flush with the ground surface, and liquid could be seen a few feet below the hole. A large EM anomaly appeared to be fully attributable to the visible concrete and metal, and masked all attempts to delineate the subsurface structure of the possible cistern. One other EM anomaly, not caused by visible sources, was found about 9 feet northeasterly of the OHM boring P40B1. It is shown on Figure 3-16 as anomaly "A". A small cylindrical piece of concrete was partially exposed at this location and may be the source of the anomaly if a metal pipe or rebar is enclosed within the concrete. EM readings at this location were around zero mmhos/m, but did not go above background at any location near the concrete.

E.3.6.2 Site P58

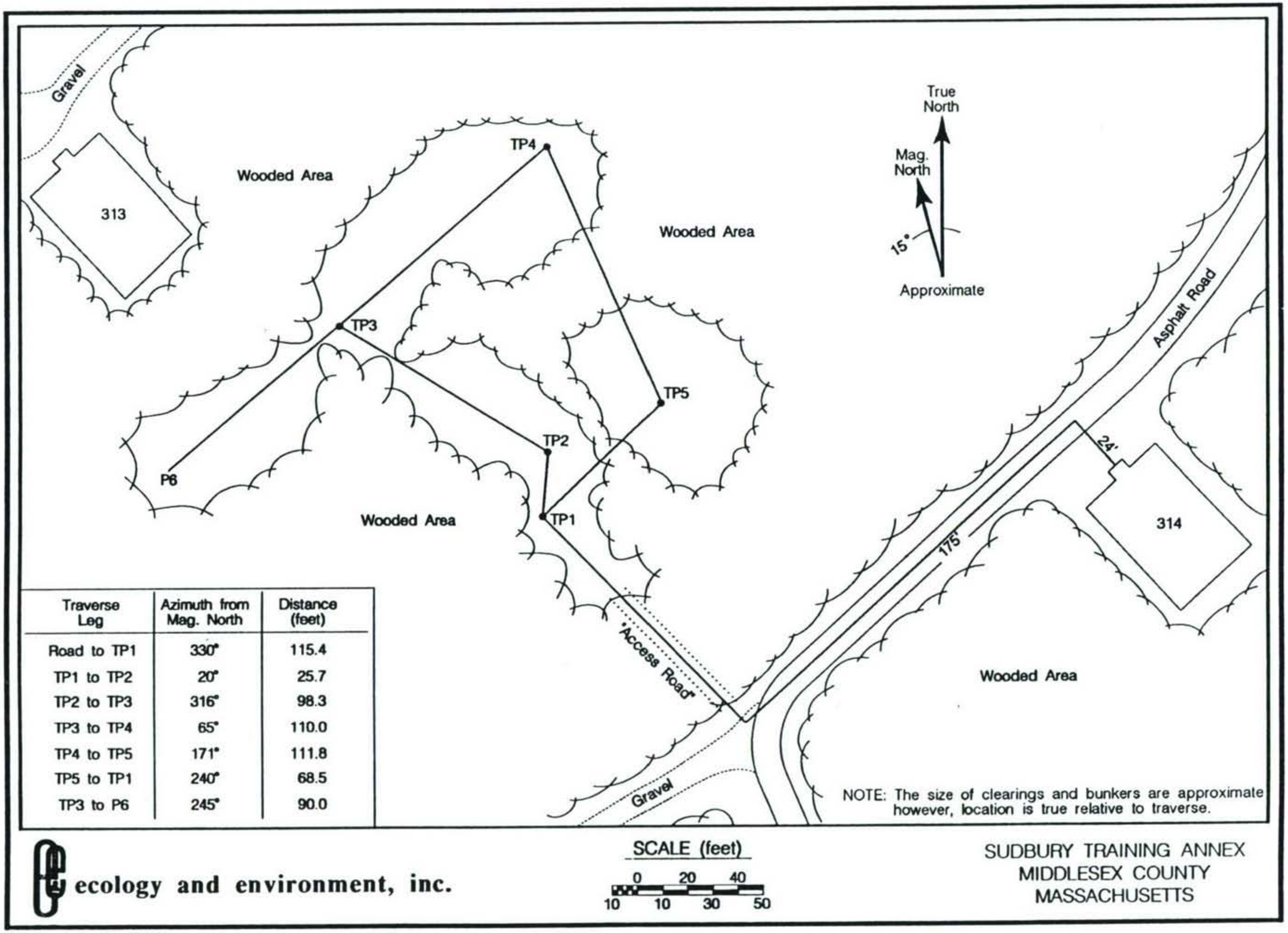
An EM reconnaissance survey was performed at the P58 site to determine the extent of a dump area. Figure 3-17 shows the approximate observable extent of the dump which contained mostly bottles with a few small cans and other household trash.

An EM background reading of 3.5 mmhos/m was taken on a dirt trail north of the site. As the operator approached the dump area EM readings increased but remained isotropic. This increase in conductivity seemed to correlate with a decrease in ground elevation and may be due to the instrument getting closer to the water table.

Only one small anomaly that could not be explained by observable metal was found in the northwest portion of the dump area. The readings of 9.0 mmhos, maximum, in the north-south direction and 3.0 mmhos/m in the east-west direction, could indicate a small metal pipe or bar fairly shallow in the subsurface. This anomaly was staked in the field, and is marked on Figure 3-17 as anomaly "A".

E.3.7 Watershed 6 — Willis Pond (Run Brook)

No geophysical surveys were performed at any site within this watershed.



Traverse Leg	Azimuth from Mag. North	Distance (feet)
Road to TP1	330°	115.4
TP1 to TP2	20°	25.7
TP2 to TP3	316°	98.3
TP3 to TP4	65°	110.0
TP4 to TP5	171°	111.8
TP5 to TP1	240°	68.5
TP3 to P6	245°	90.0

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Figure 3-1: P56 STUDY AREA - GEOPHYSICAL SURVEY LOCATION MAP

sud-p56.cdr

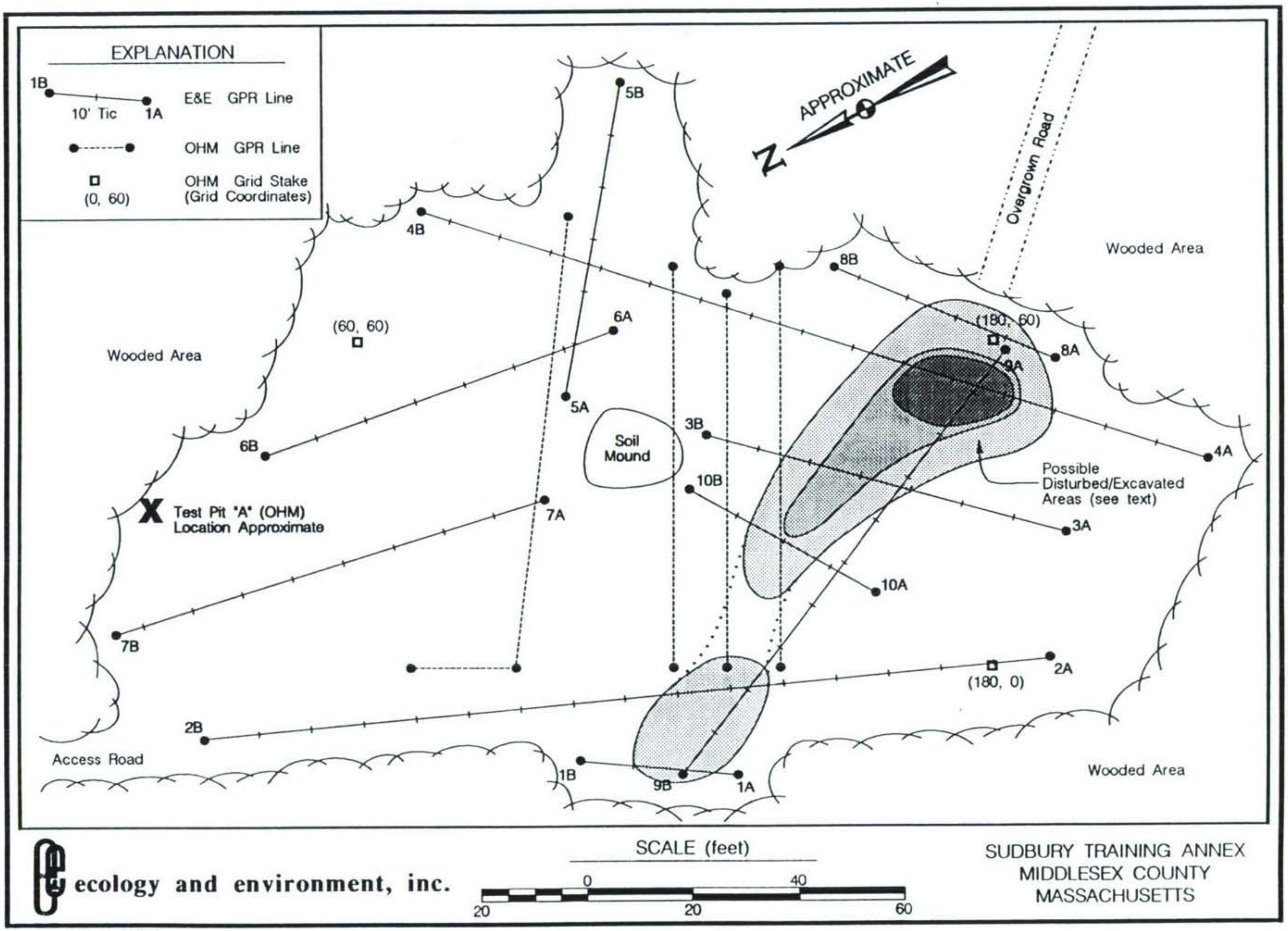

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Figure 3-2: A1 STUDY AREA - GPR SURVEY

sud-a1.cdr

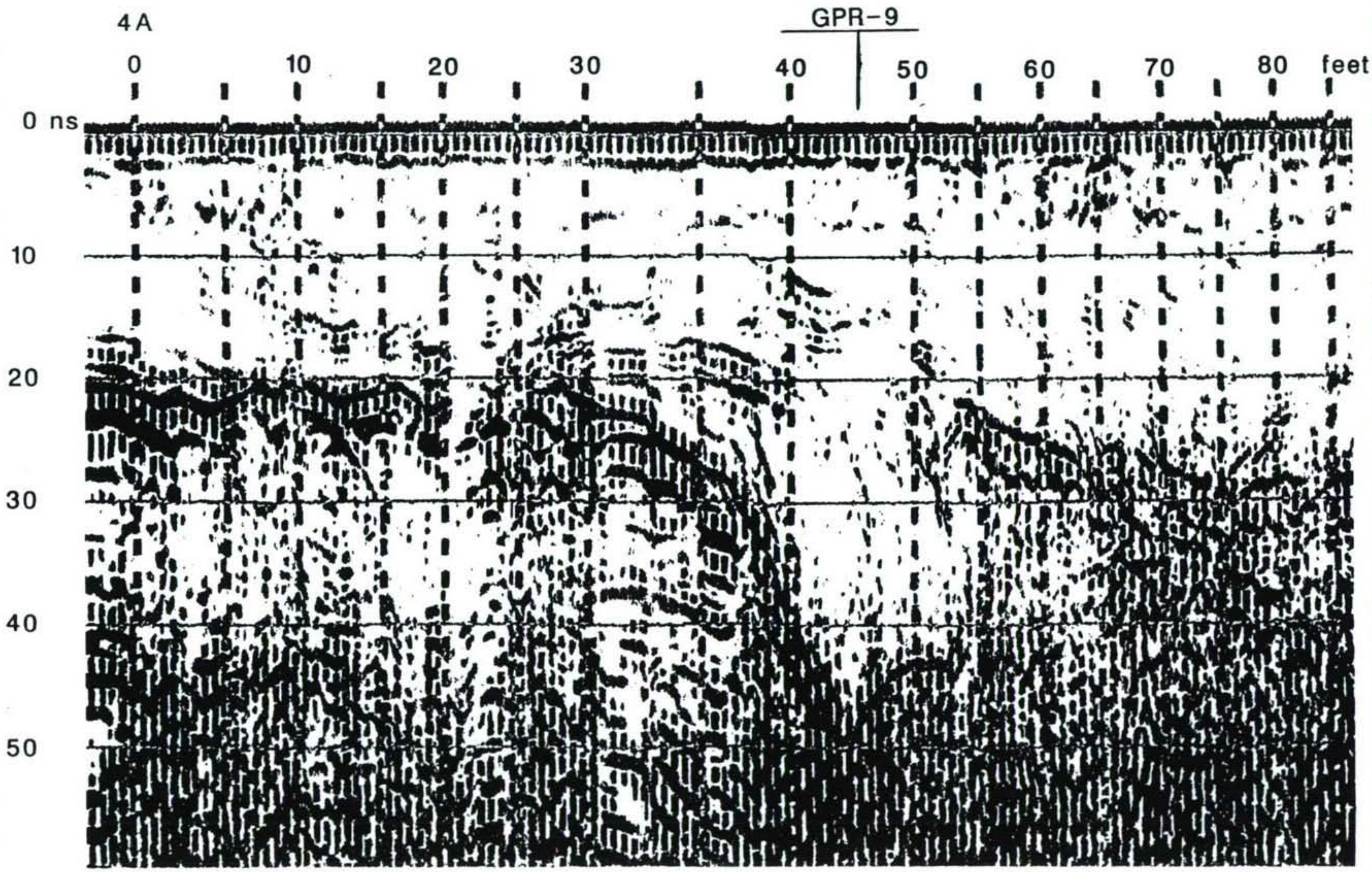

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Figure 3-3: A1 STUDY AREA - GPR LINE GPR-4 (PARTIAL)

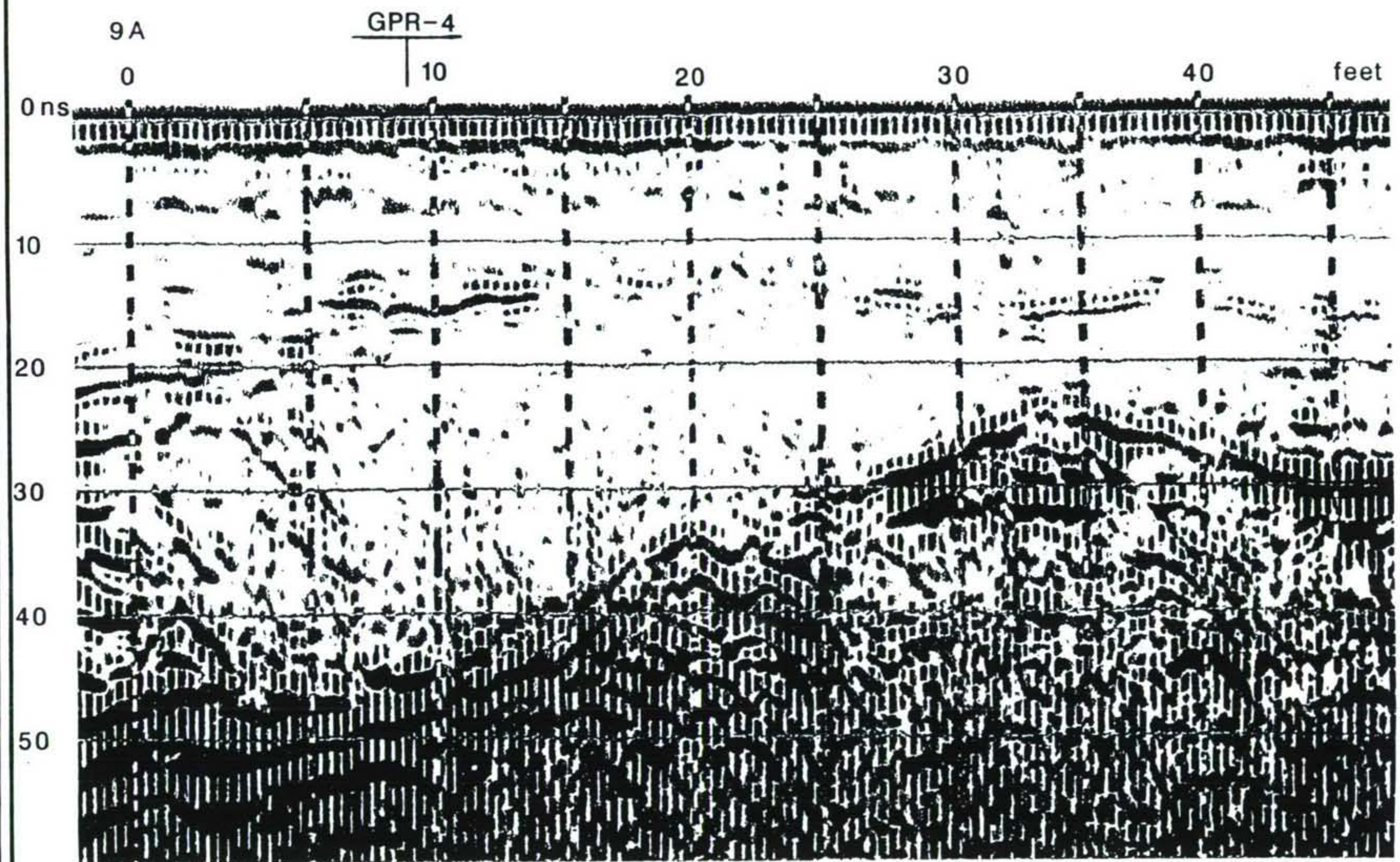

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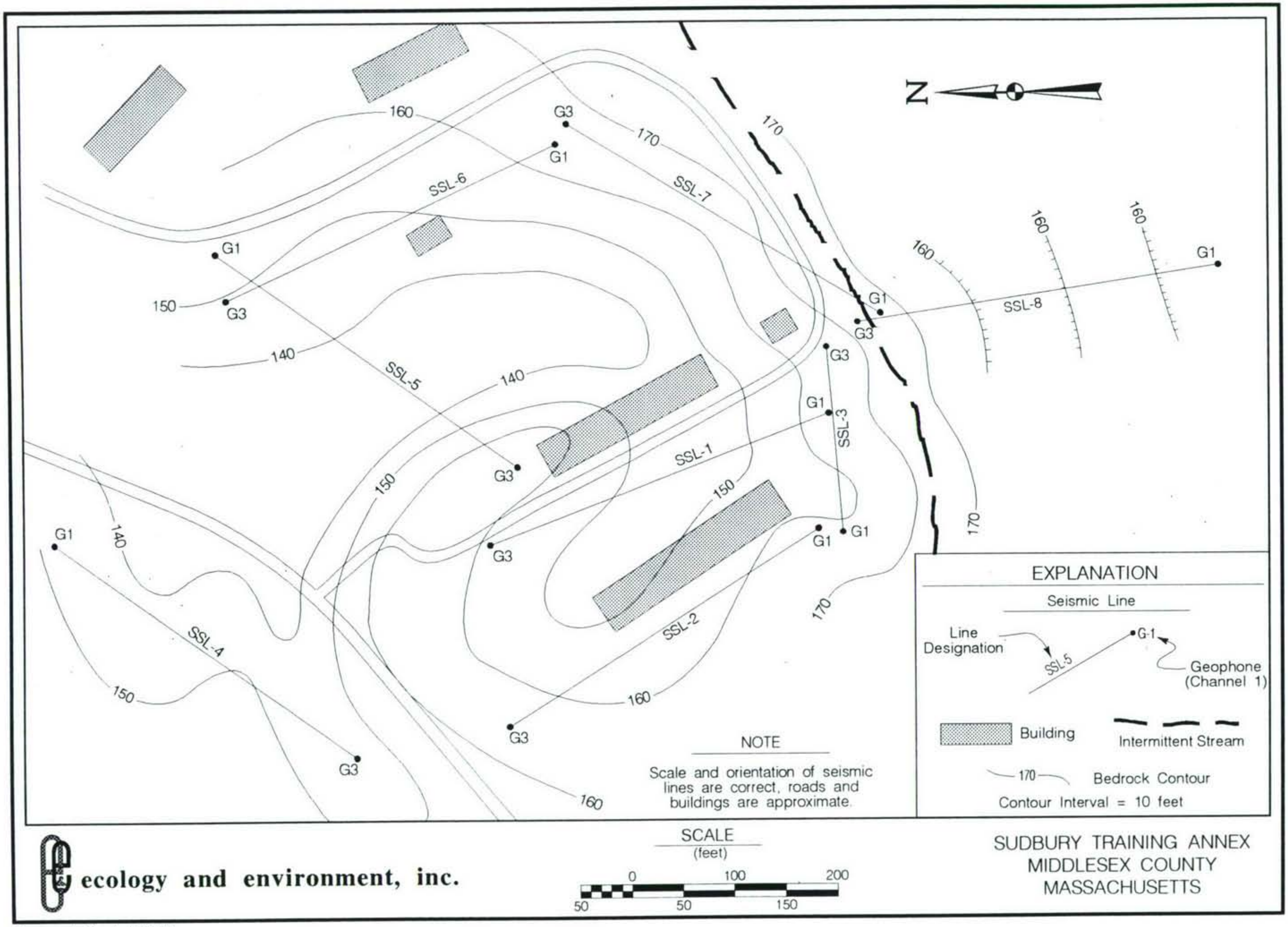
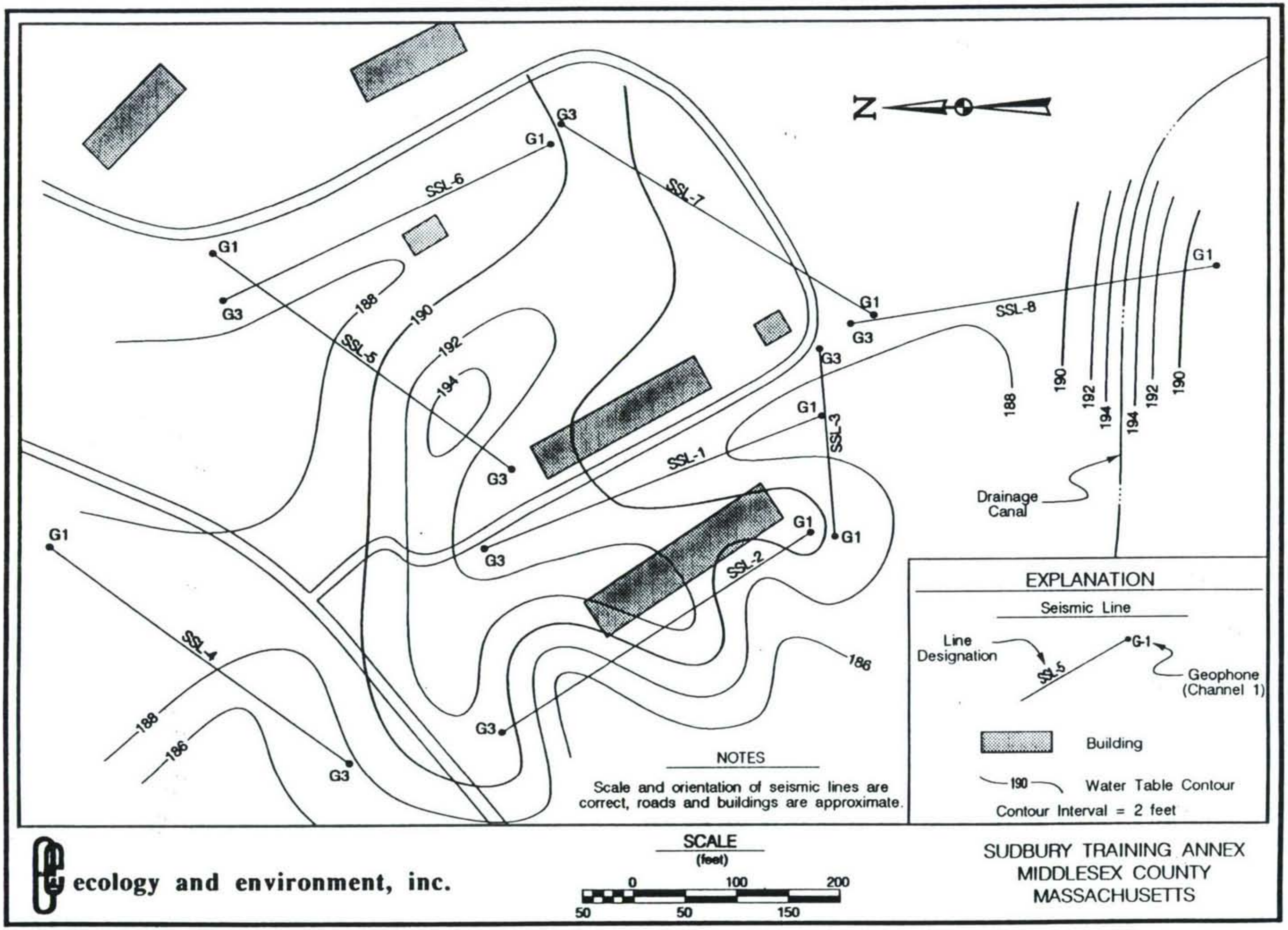
Figure 3-4: A1 STUDY AREA - GPR LINE GPR-9 (PARTIAL)



Prepared By: L.J.BAER

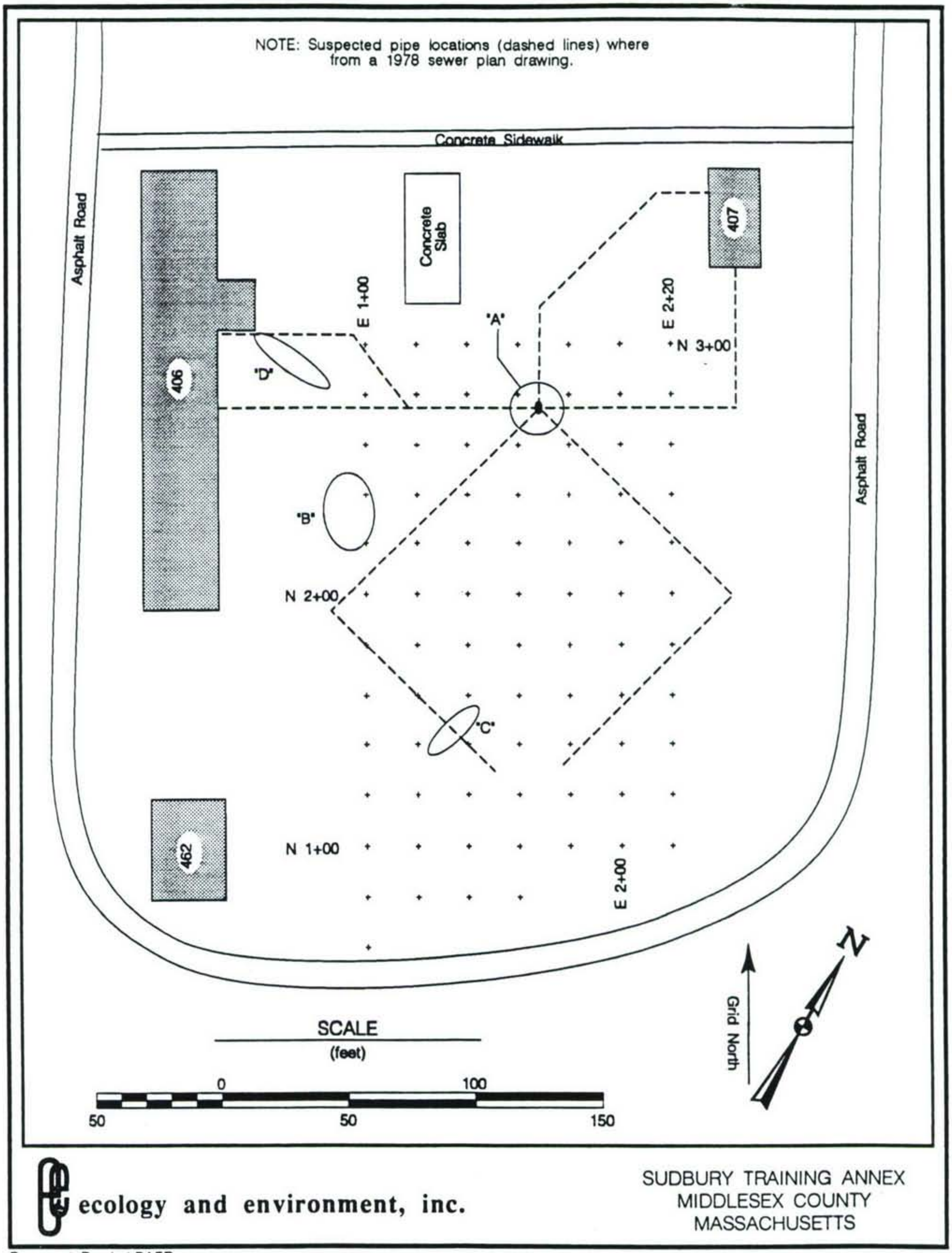
Figure 3-5: P11/P13 STUDY AREA - GENERALIZED BEDROCK CONTOUR MAP



Prepared By: L.J.BAER

Figure 3-6: P11/P13 STUDY AREA - GENERALIZED GROUNDWATER CONTOUR MAP

sud11wtr.cdr



Prepared By: L.J.BAER

Figure 3-7: P13 STUDY AREA - GEOPHYSICAL GRID LOCATION MAP

p13-geop.cdr

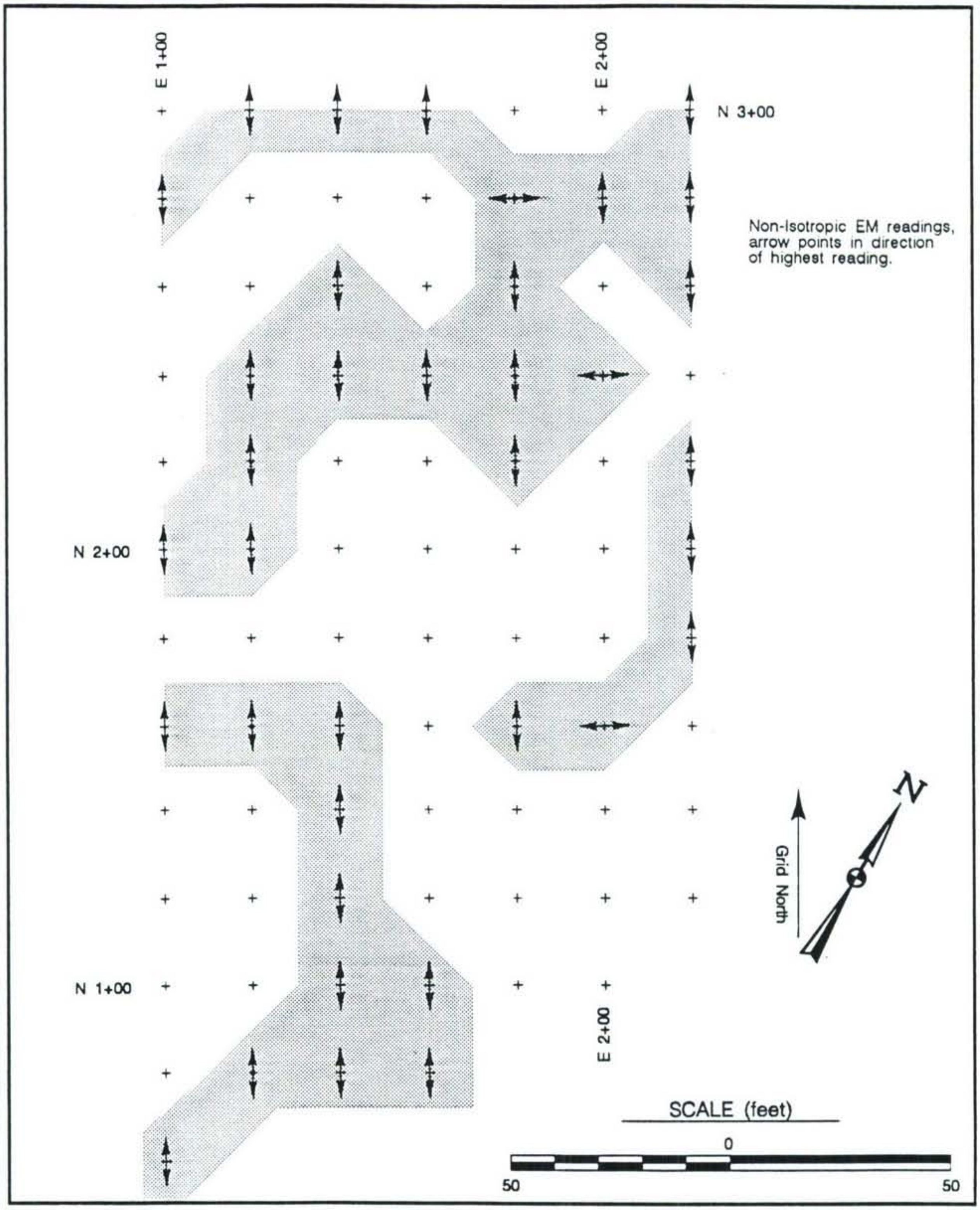


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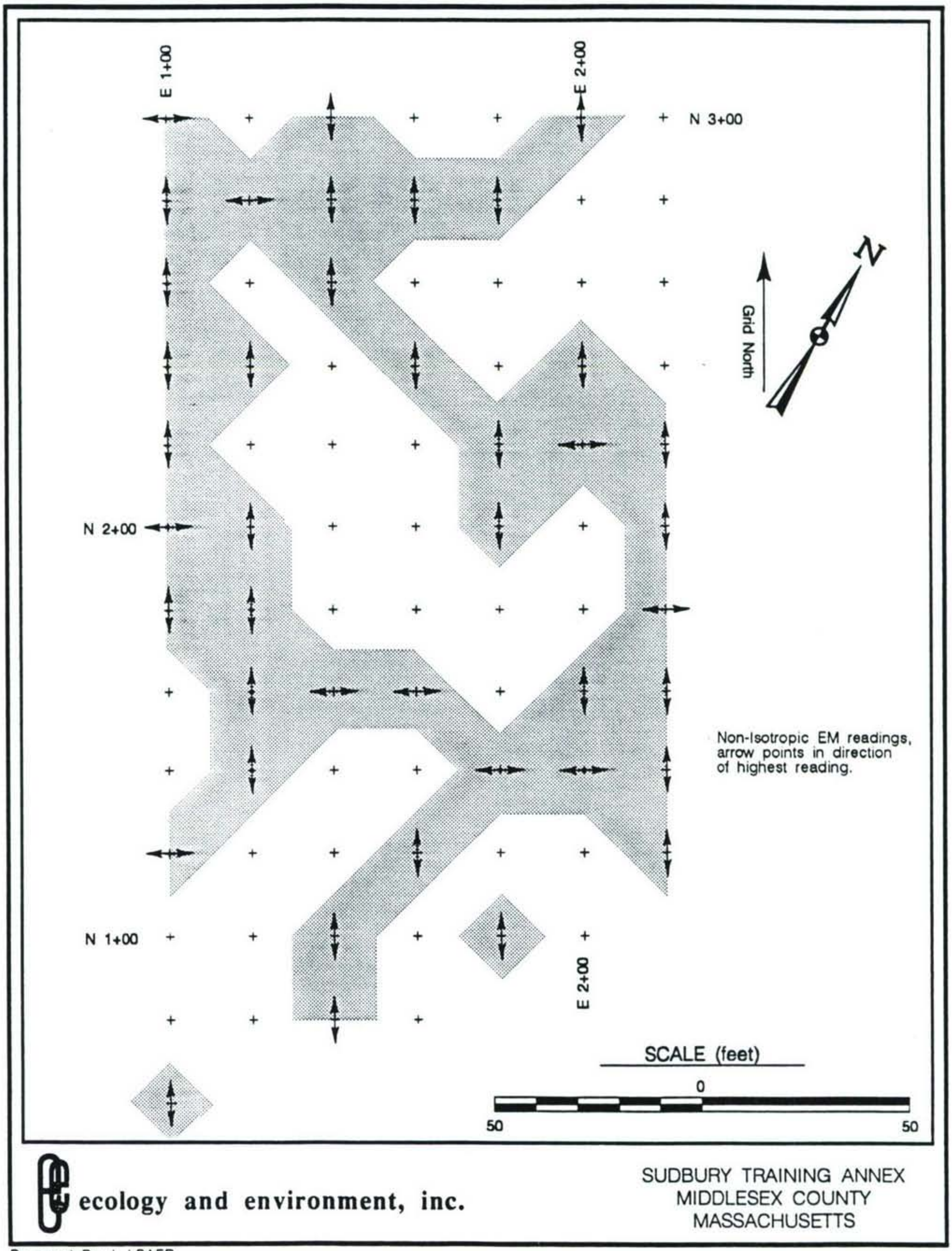
Figure 3-8: P13 STUDY AREA - EM31 VERTICAL DIPOLE

p13-emvl.cdr



Prepared By: L.J.BAER

Figure 3-9: P13 STUDY AREA - EM31 HORIZONTAL DIPOLE

p13-emhz.cdr

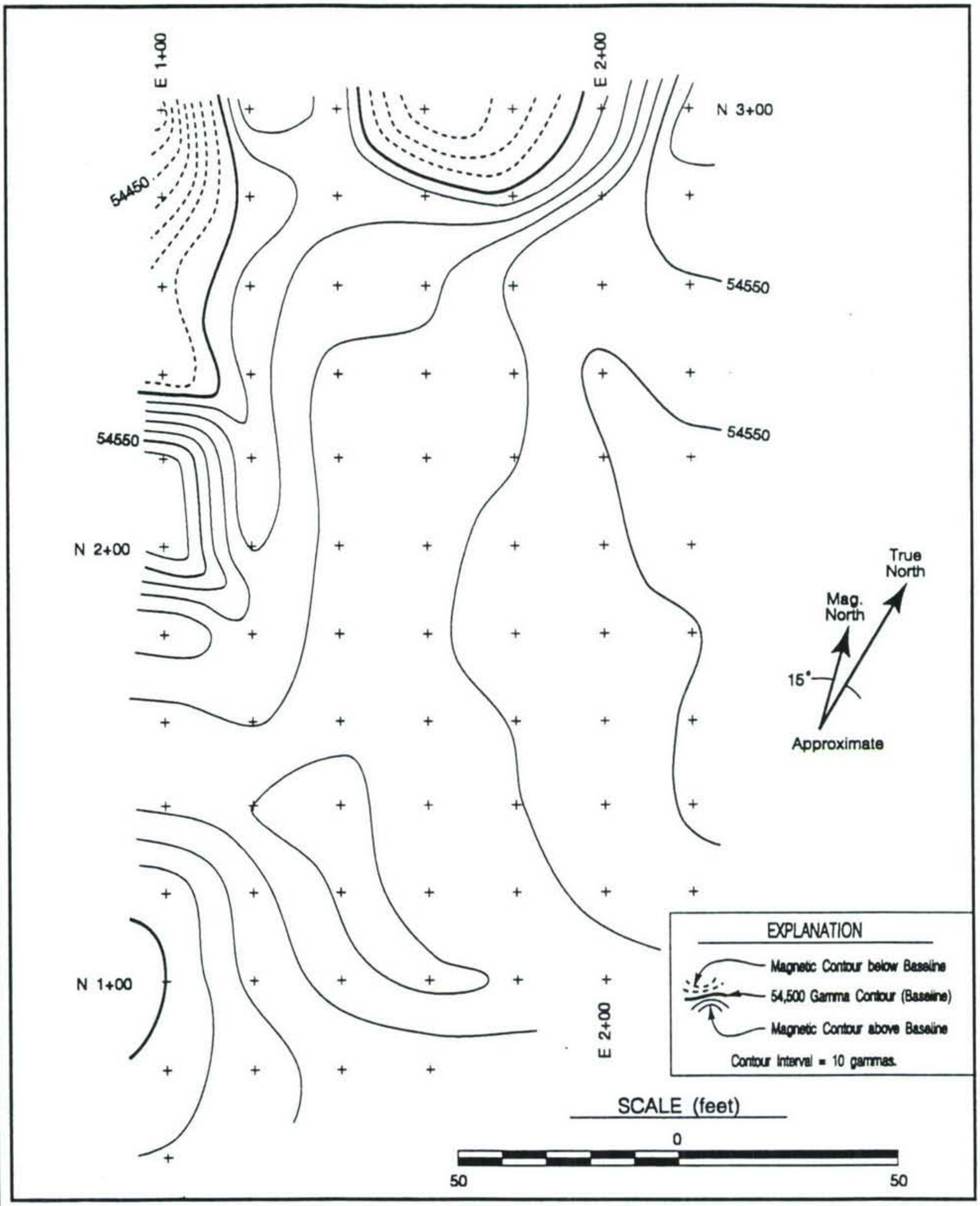


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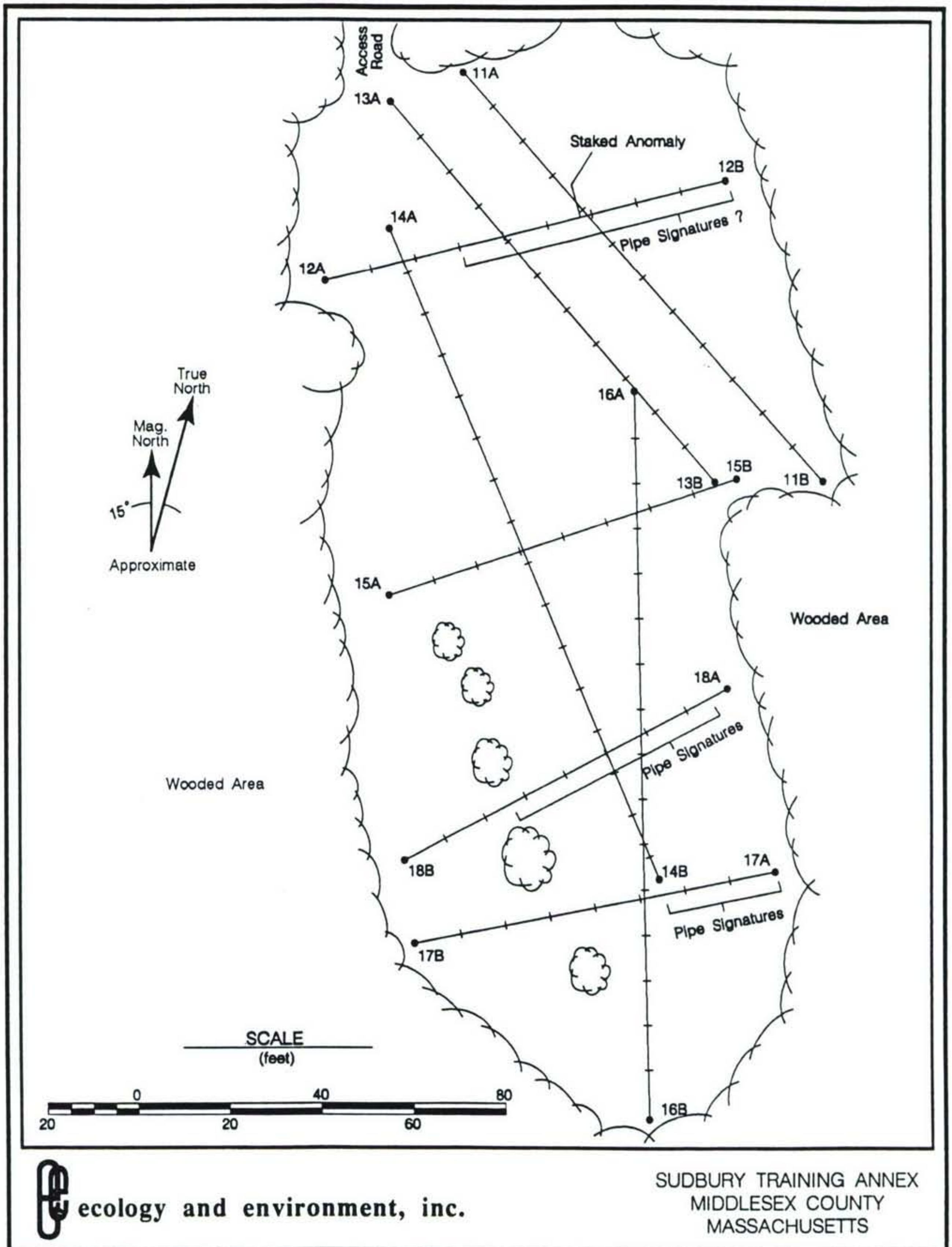
Figure 3-10: P13 STUDY AREA - TOTAL MAGNETIC FIELD CONTOUR MAP

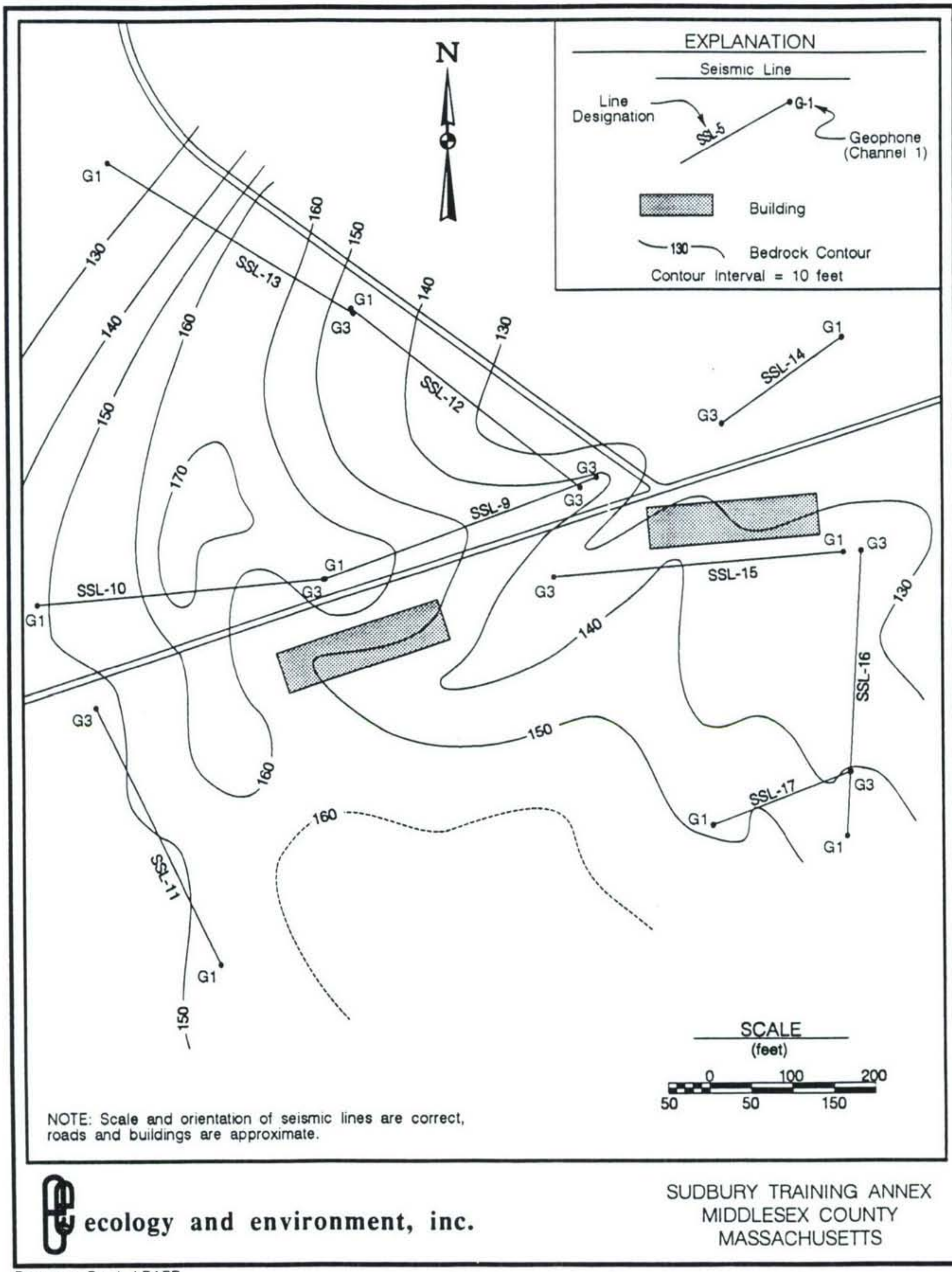
p13-mag.cdr



Prepared By: L.J.BAER

Figure 3-11: A11 STUDY AREA (South Portion) - GPR SURVEY

sud-a11.cdr



Prepared By: L.J.BAER

Figure 3-12: P36/P37 STUDY AREA - GENERALIZED BEDROCK CONTOUR MAP

sud36roc.cdr

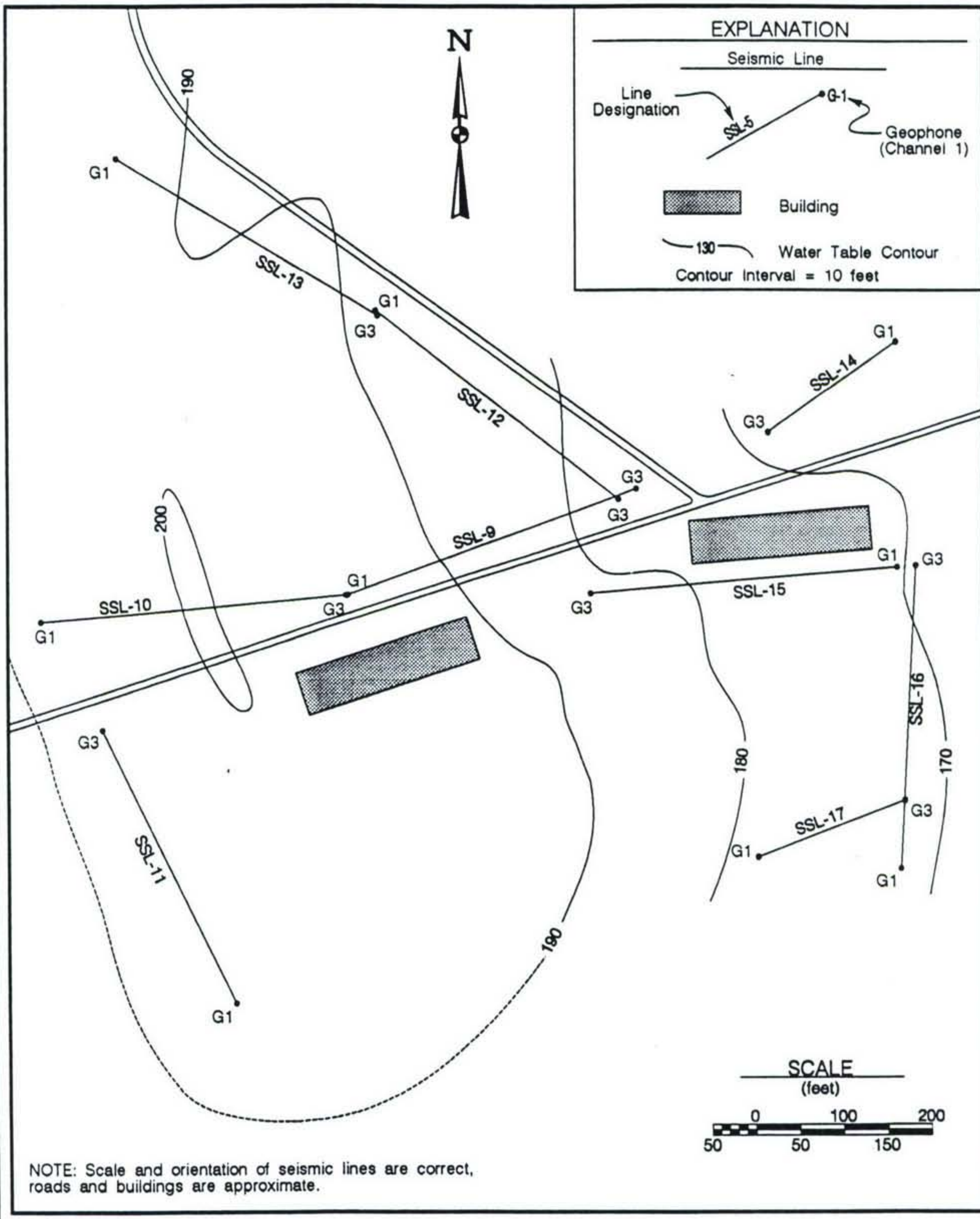


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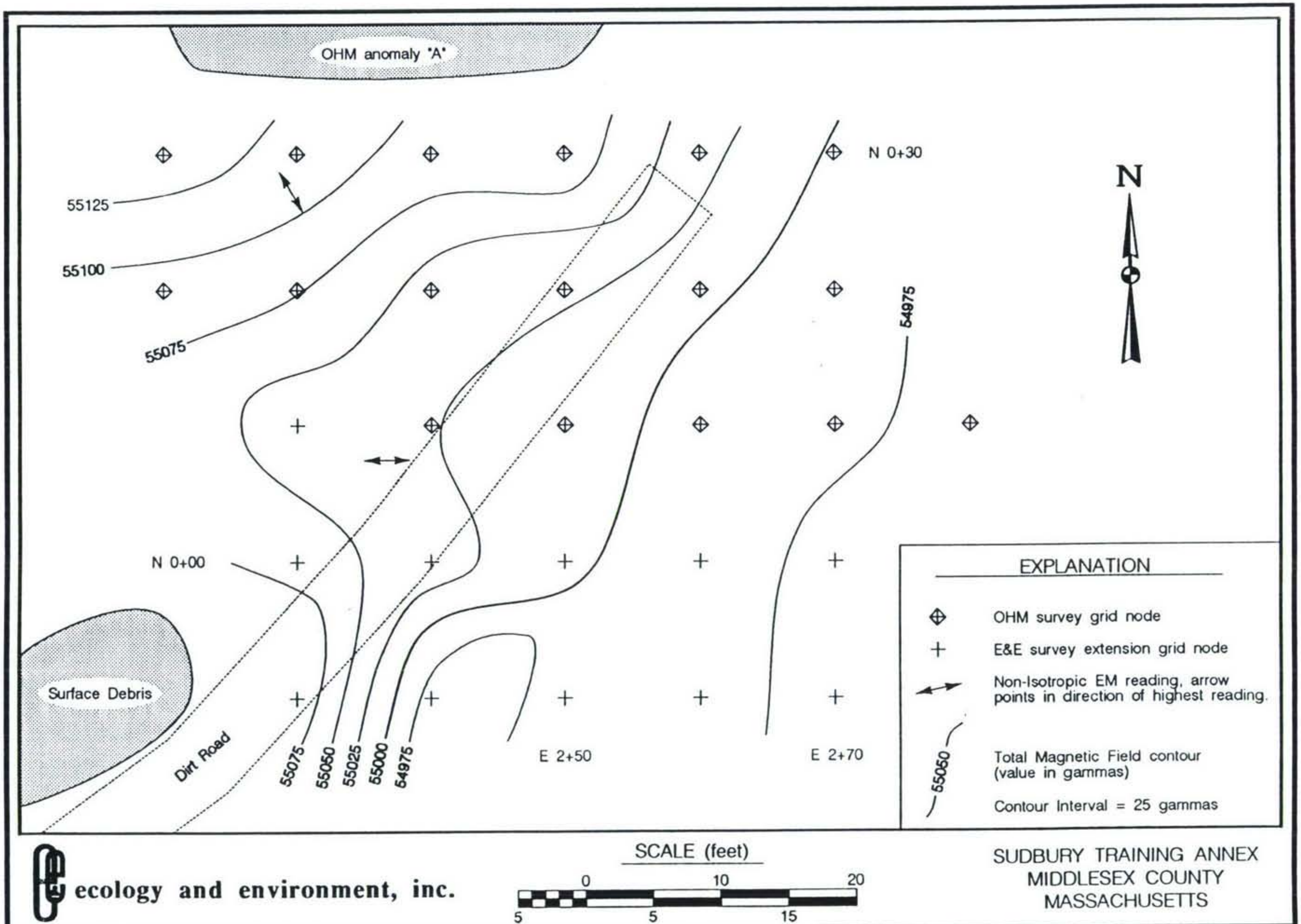
Figure 3-13: P36/P37 STUDY AREA - GENERALIZED GROUNDWATER CONTOUR MAP

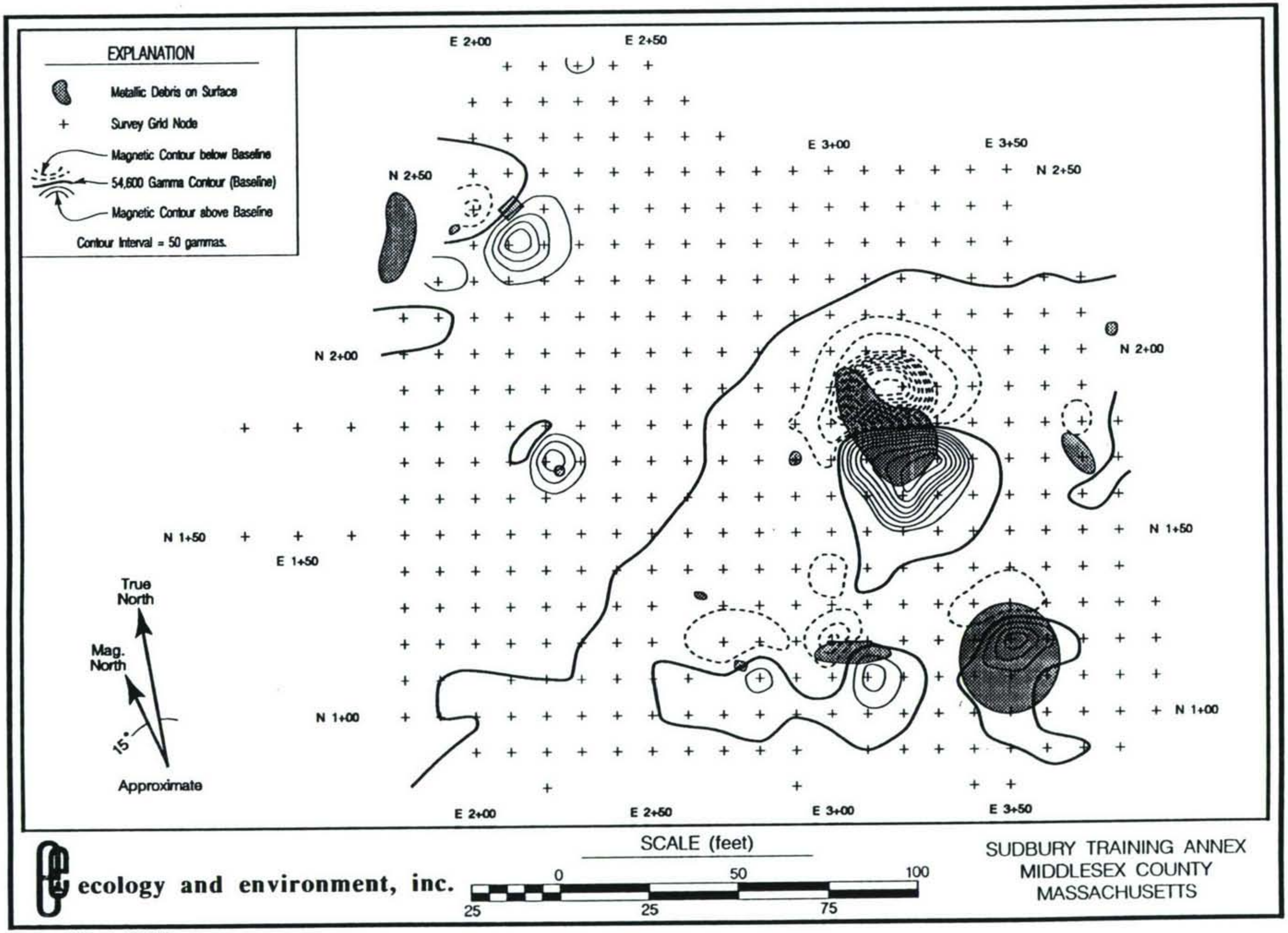
sud36wtr.cdr



Prepared By: L.J.BAER

Figure 3-14: P39 STUDY AREA - TOTAL MAGNETIC FIELD CONTOUR MAP

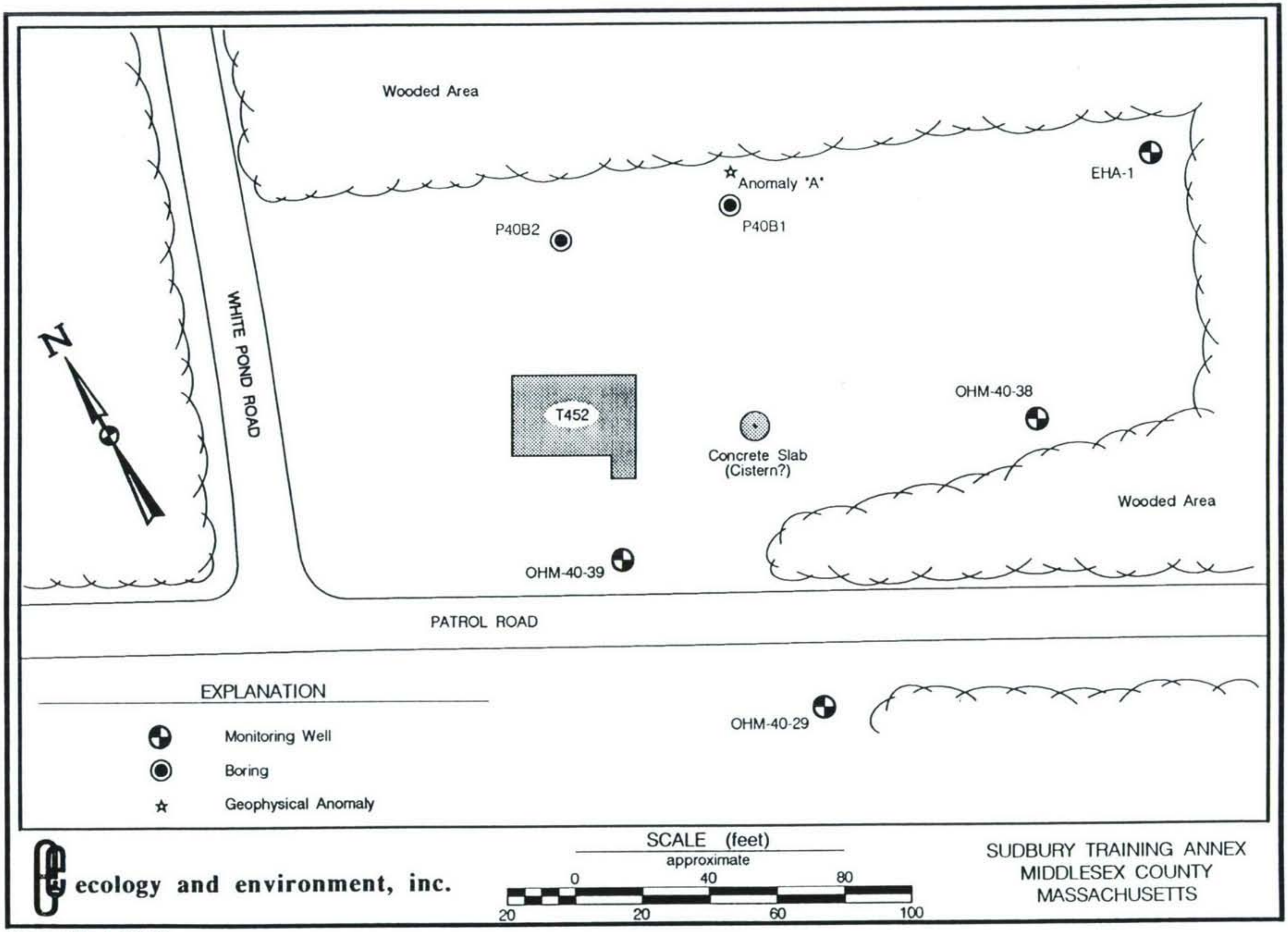
sud-p39.cdr



Prepared By: L.J.BAER

Figure 3-15: P22 STUDY AREA - TOTAL MAGNETIC FIELD CONTOUR MAP

sud-p22.cdr



Prepared By: L.J.BAER

Figure 3-16: P40 STUDY AREA - GEOPHYSICAL SURVEY LOCATION MAP

sud-p40.cdr

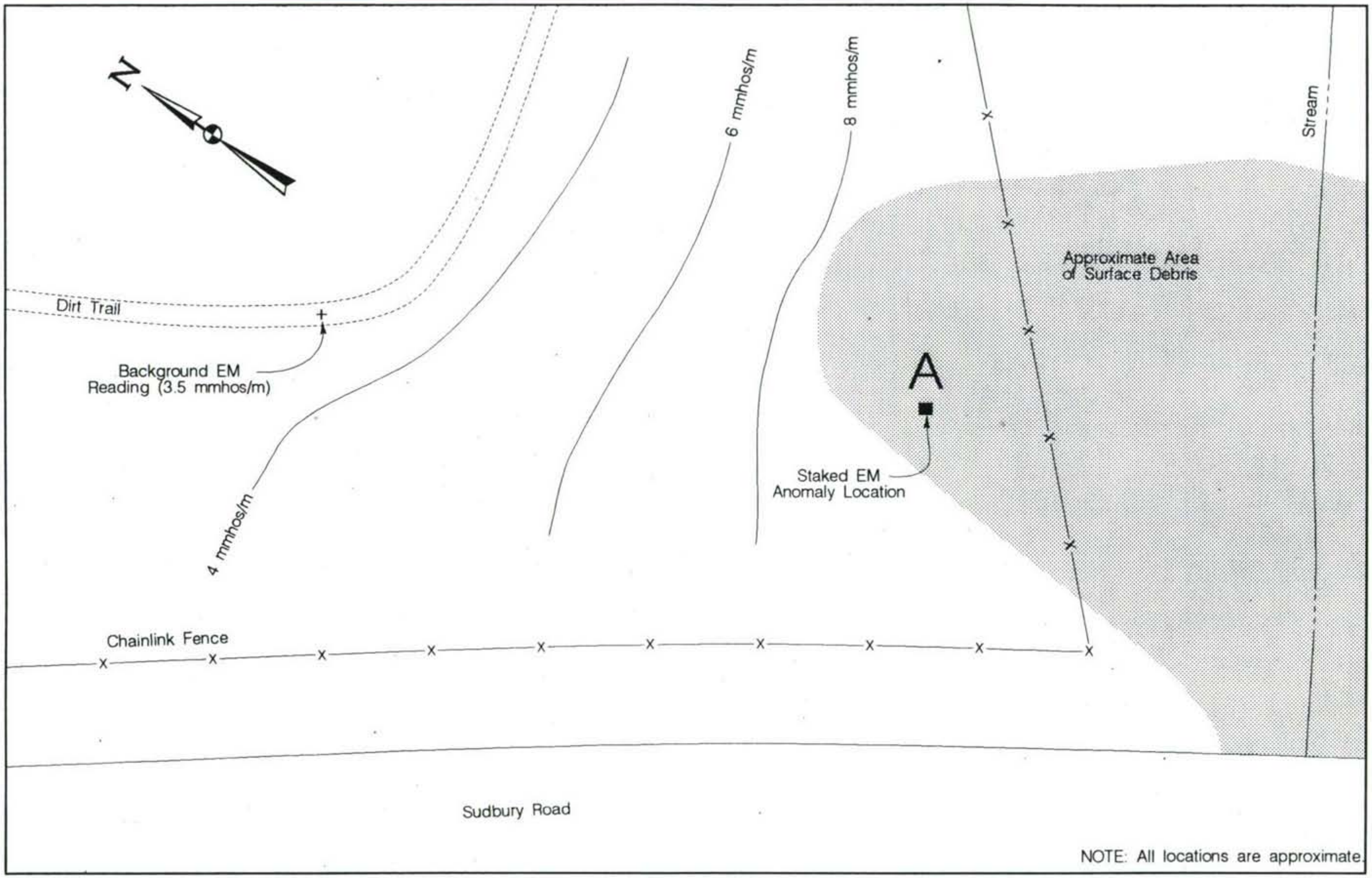


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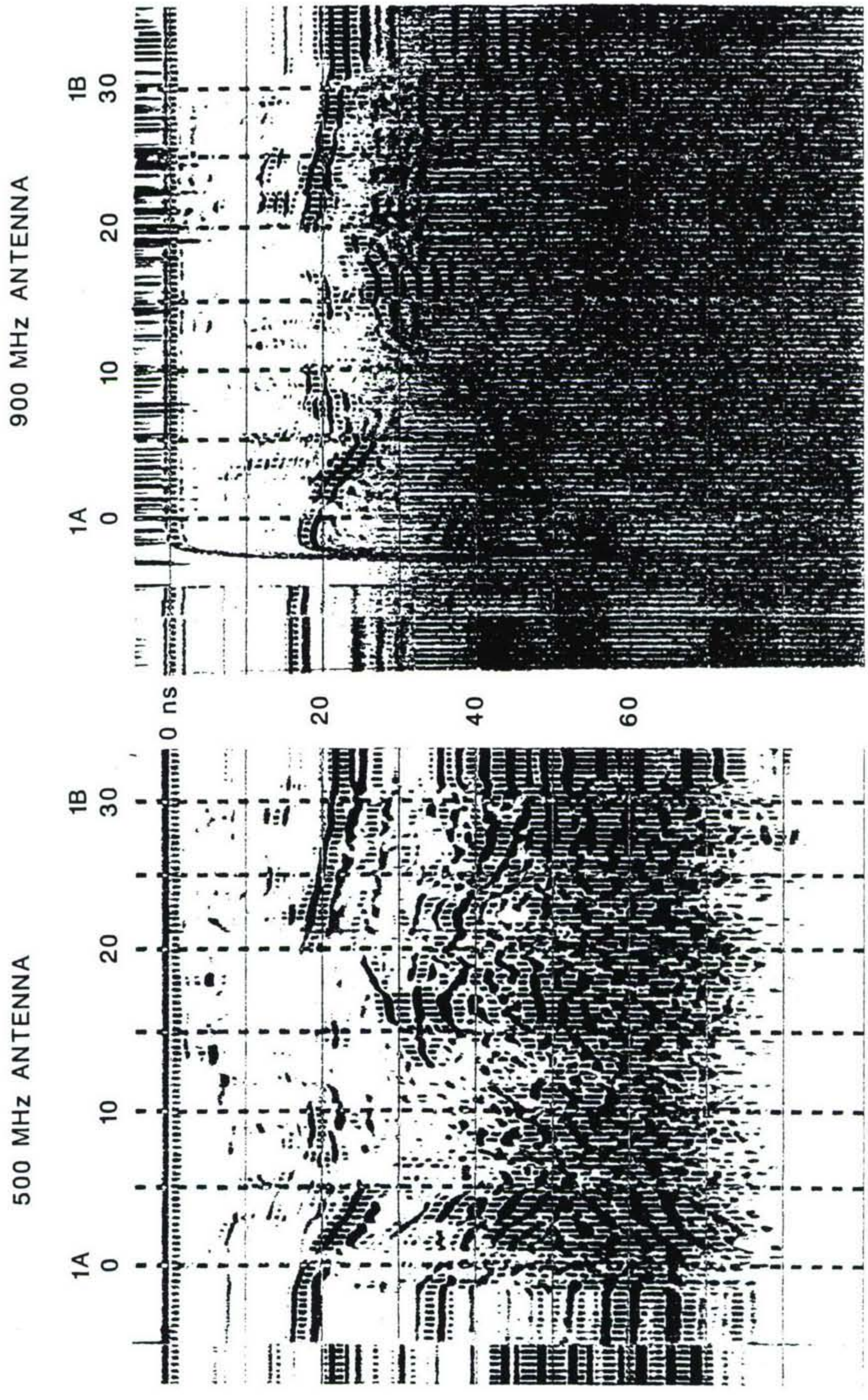
Figure 3-17: P58 STUDY AREA - EM SURVEY LOCATION MAP

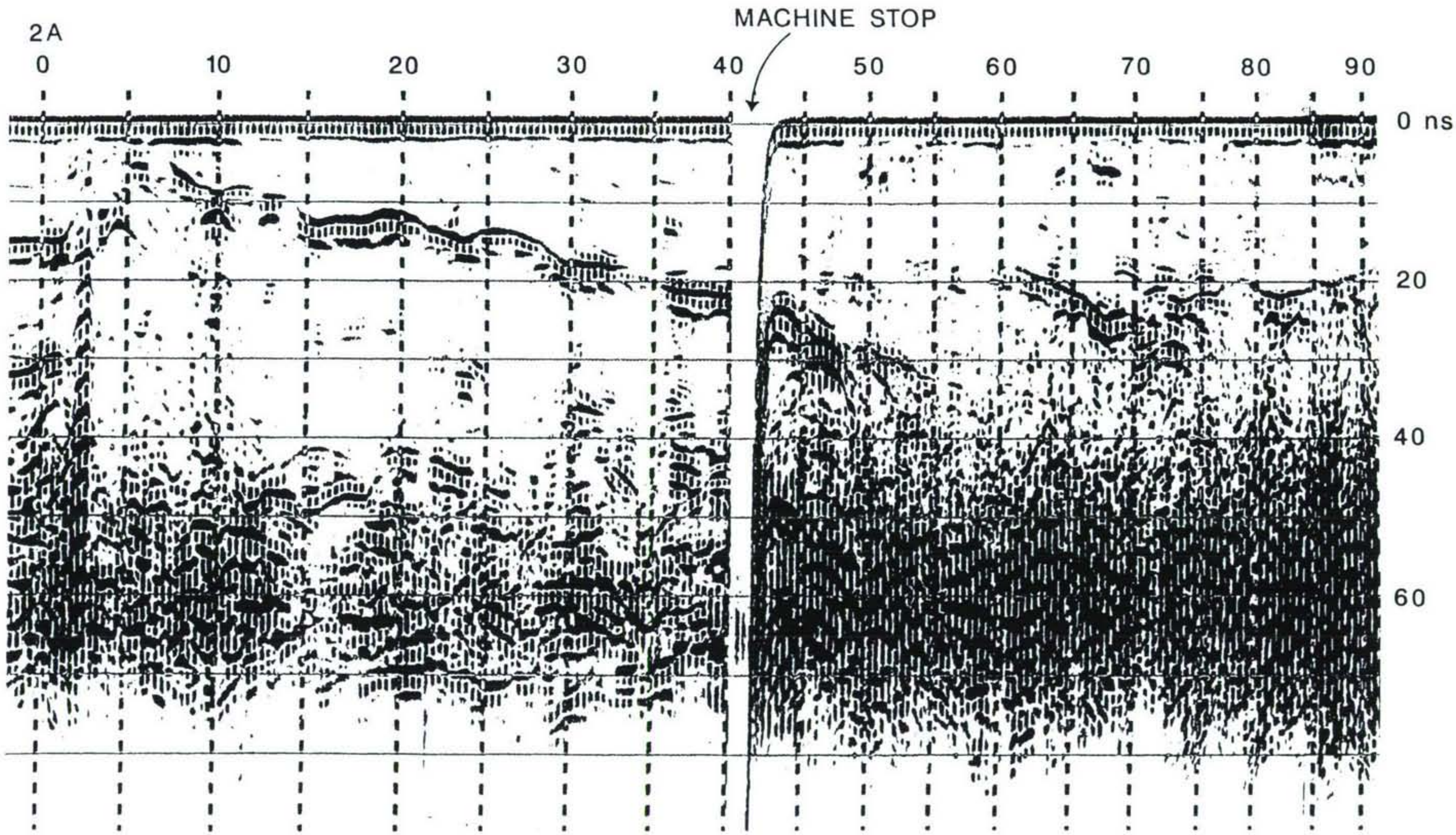
APPENDIX E

ATTACHMENT A

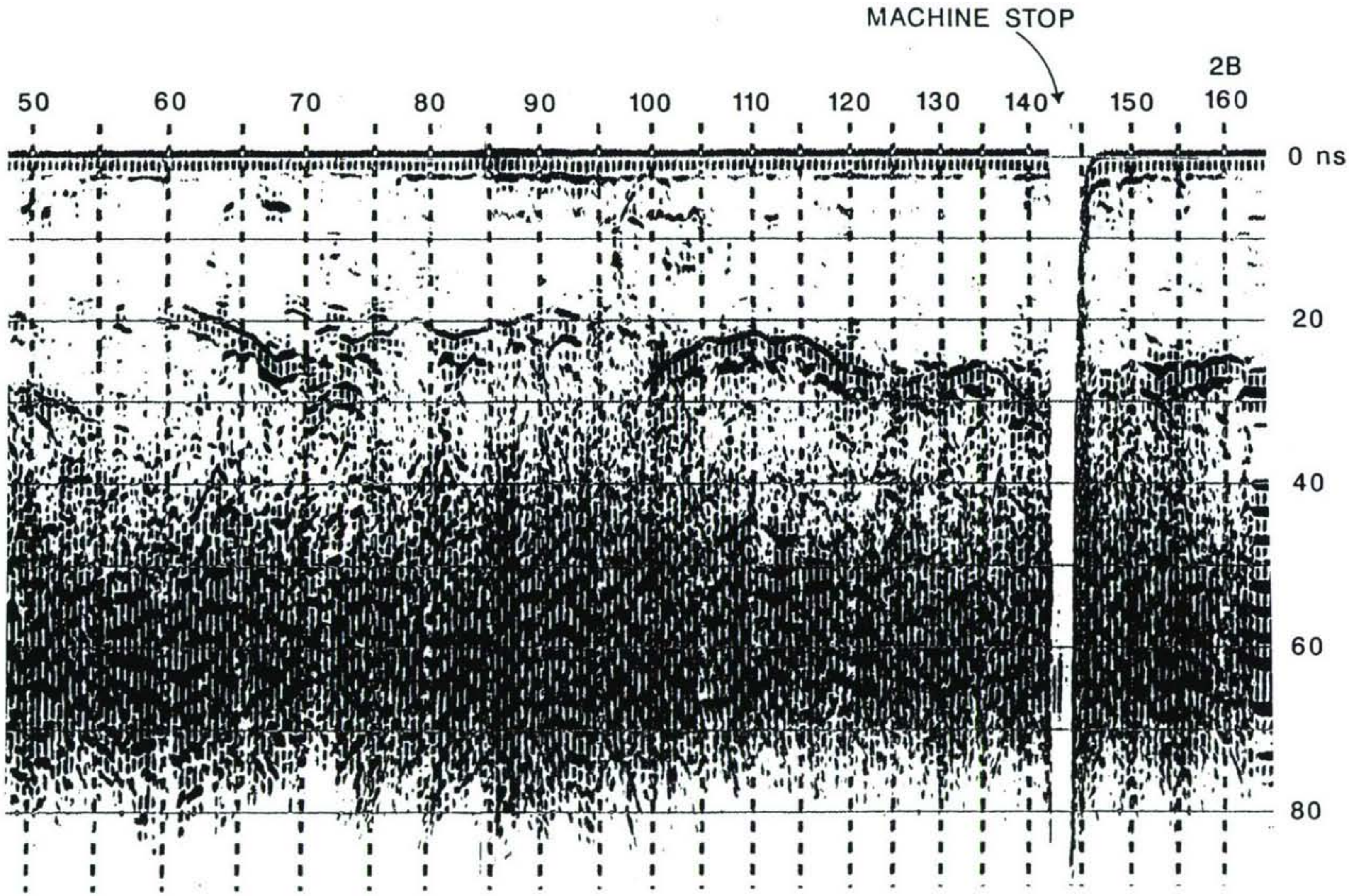
A1 STUDY AREA
GPR PROFILES



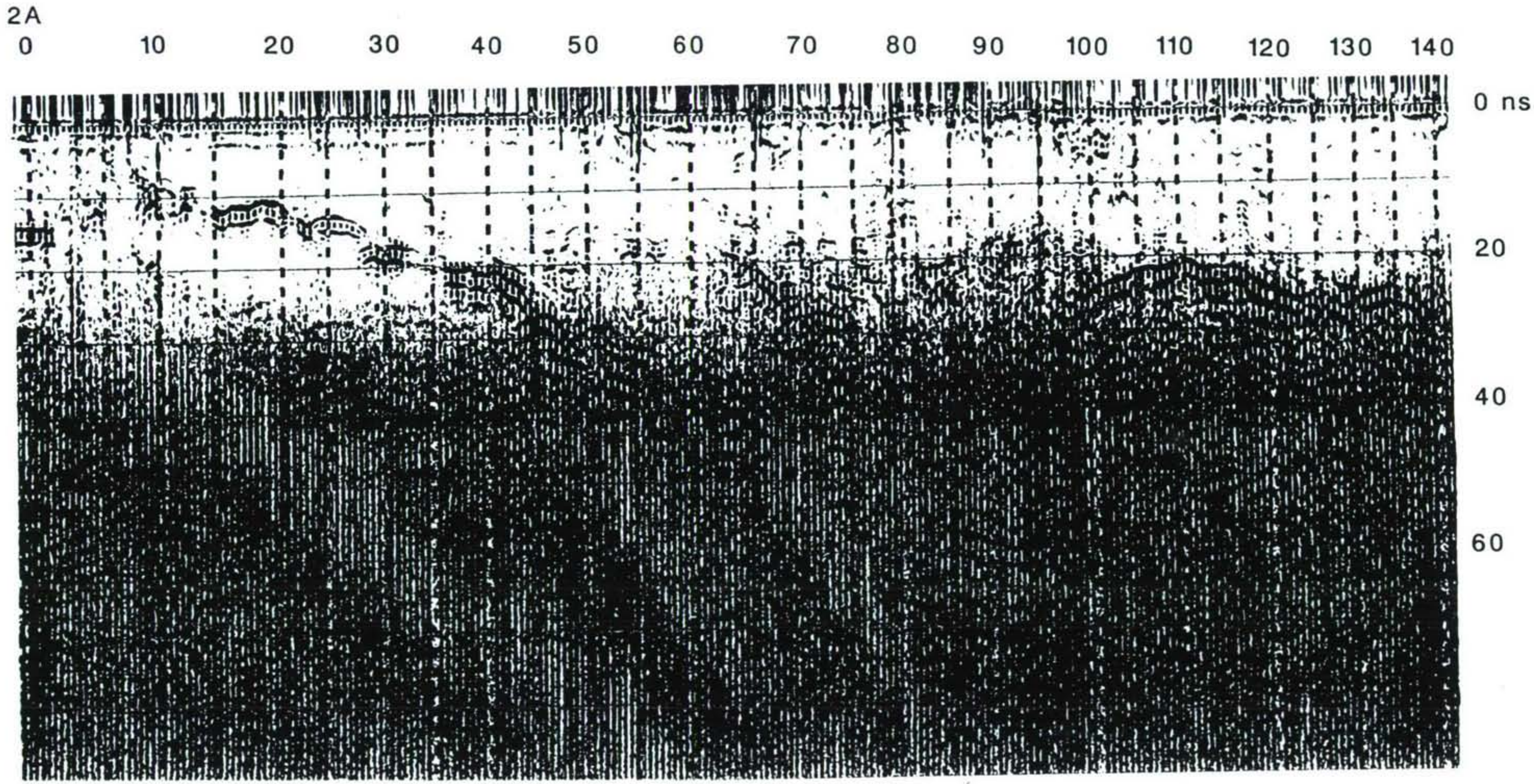
A1 STUDY AREA - LINE GPR-1



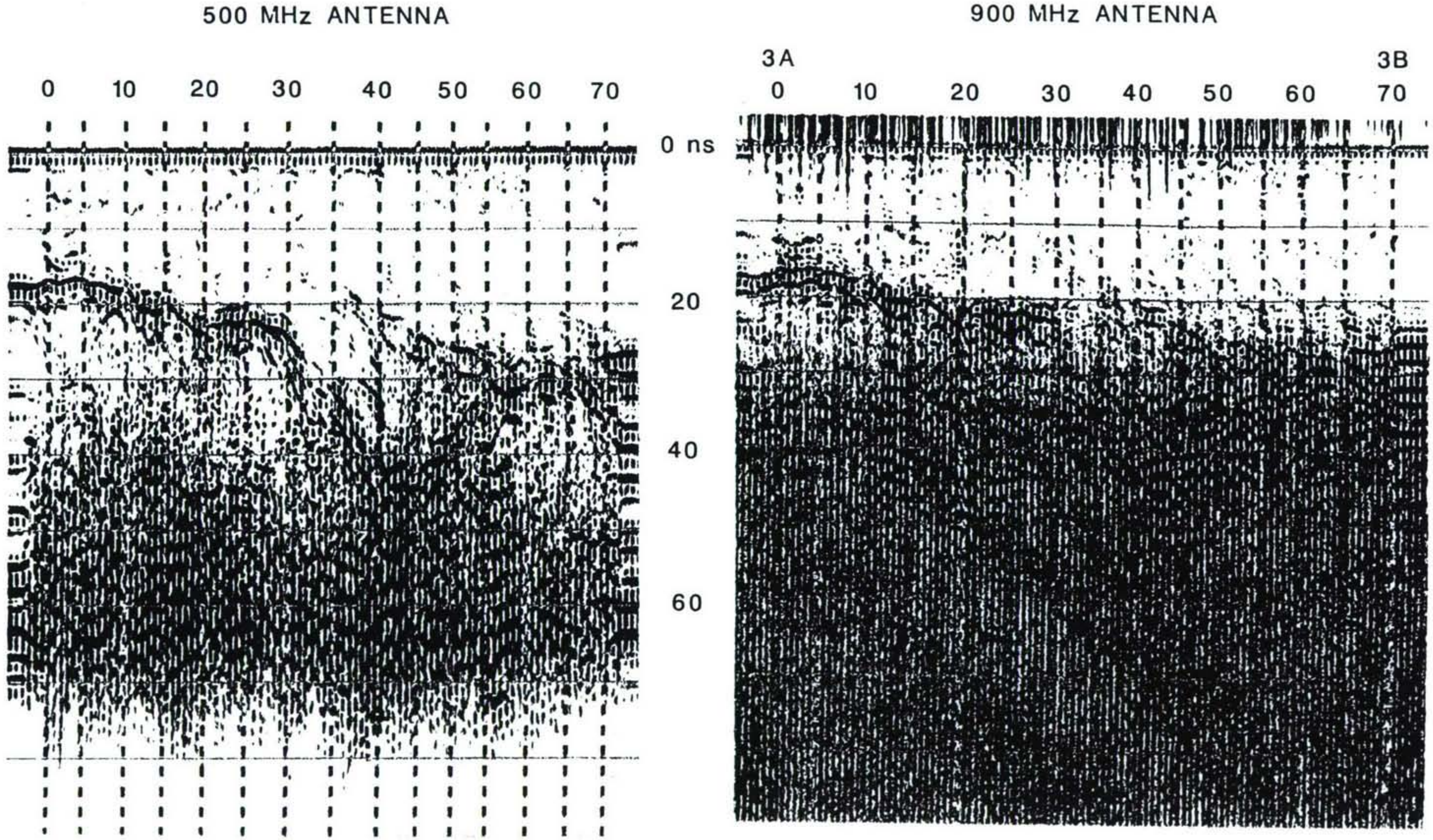
A1 STUDY AREA - PARTIAL LINE GPR-2 (500 MHz ANTENNA)



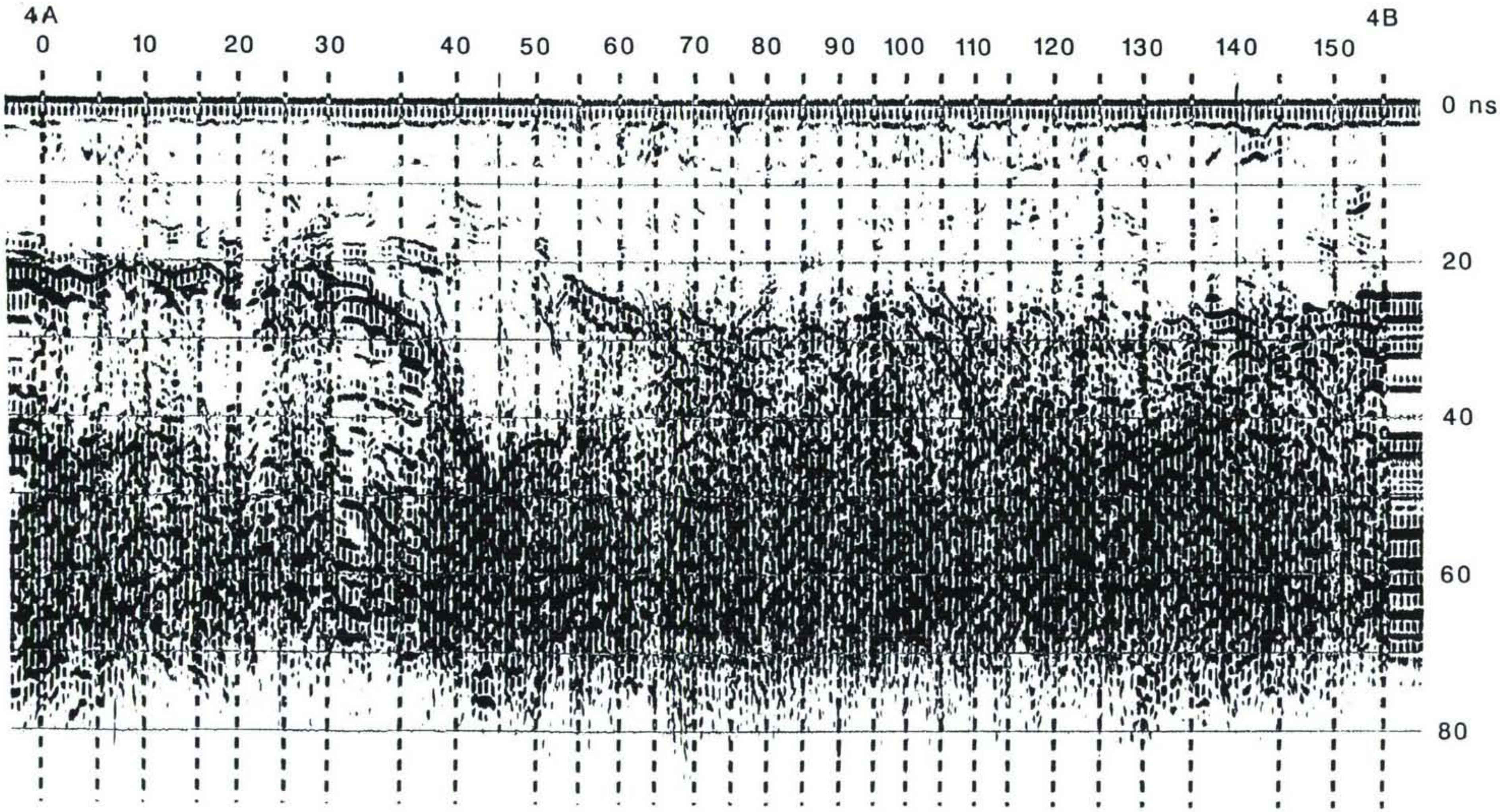
A1 STUDY AREA - PARTIAL LINE GPR-2 (500 MHz ANTENNA)



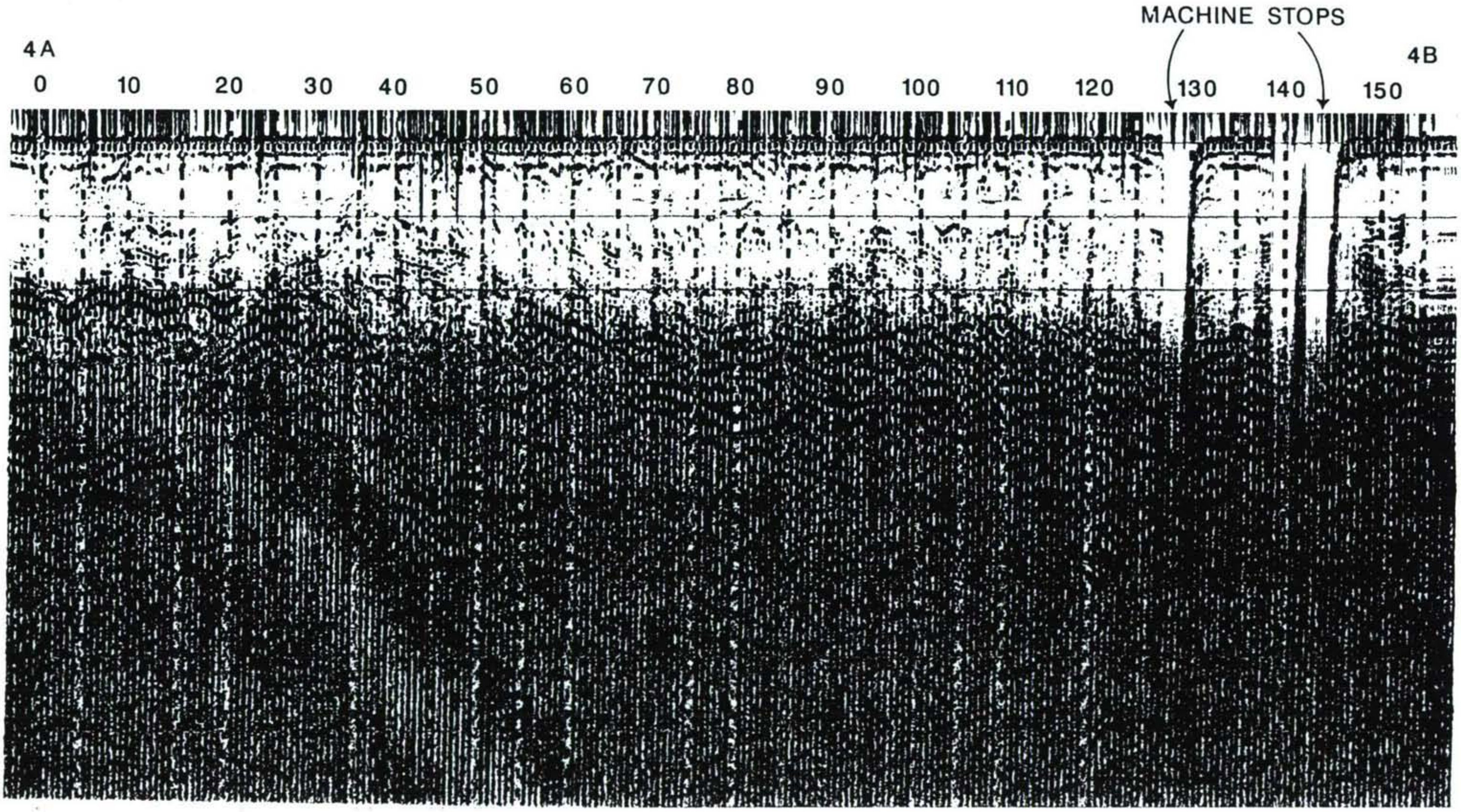
A1 STUDY AREA - LINE GPR-2 (900 MHz ANTENNA)
(0-140 ONLY)



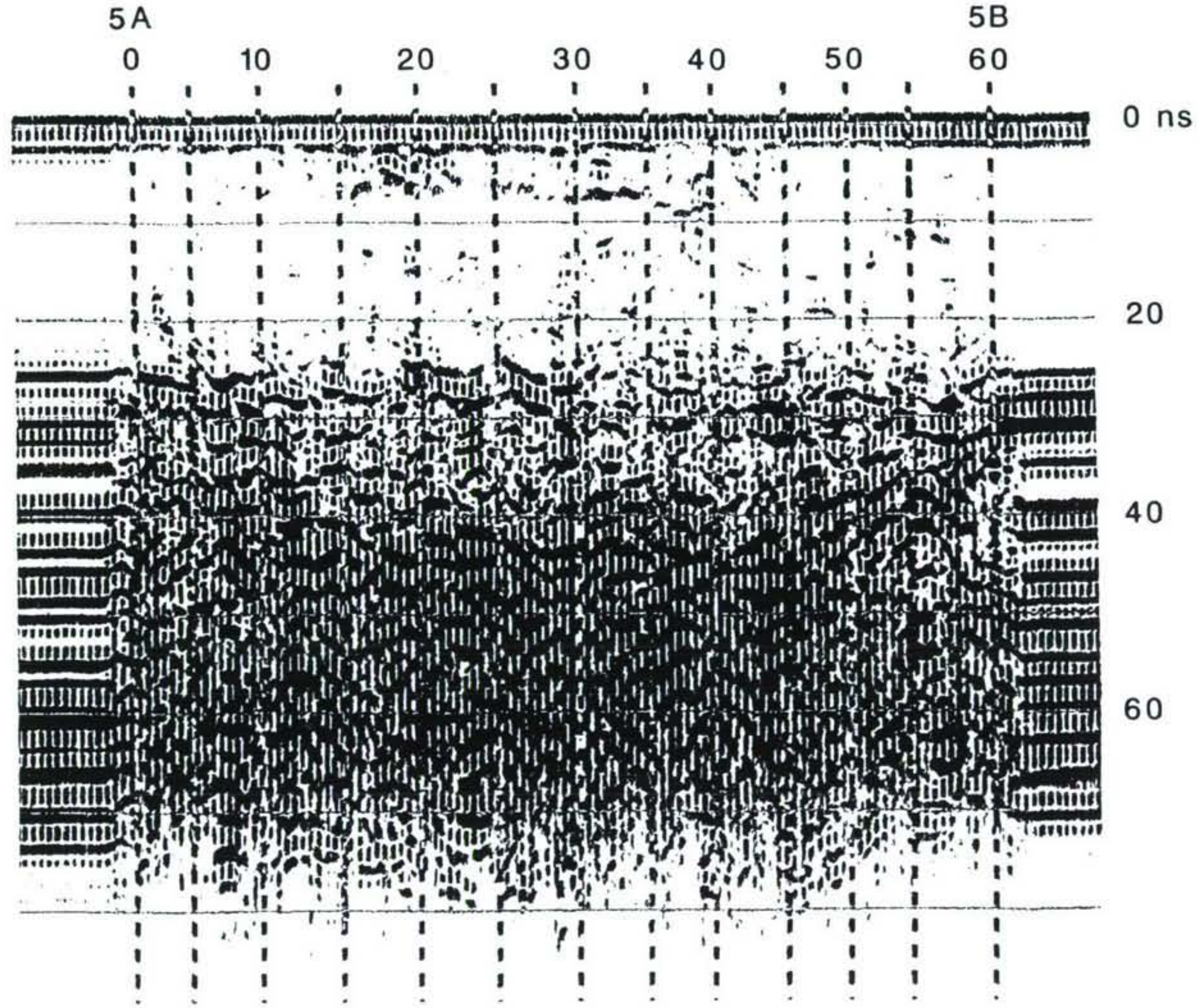
A1 STUDY AREA - LINE GPR-3



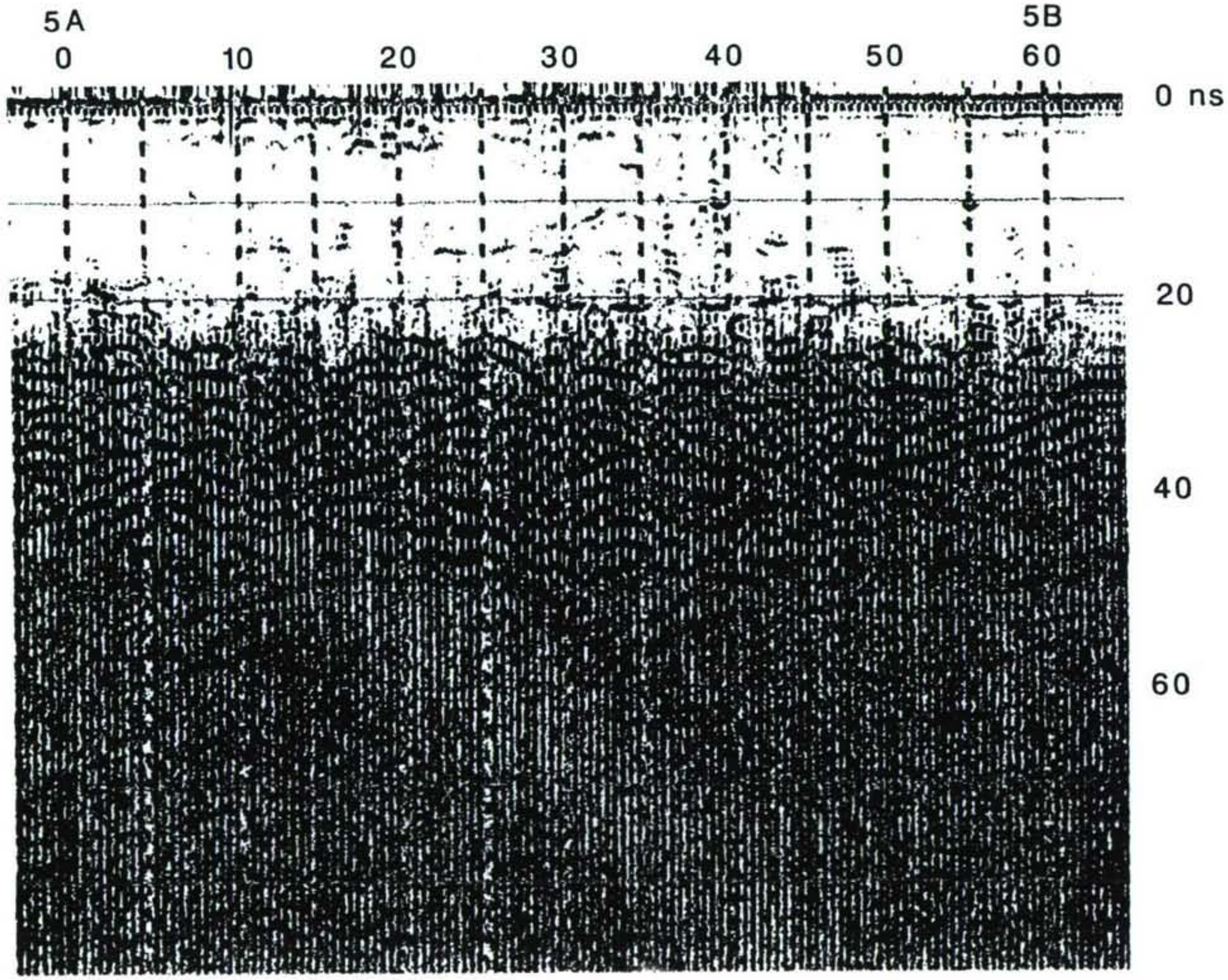
A1 STUDY AREA - LINE GPR-4 (500 MHz ANTENNA)



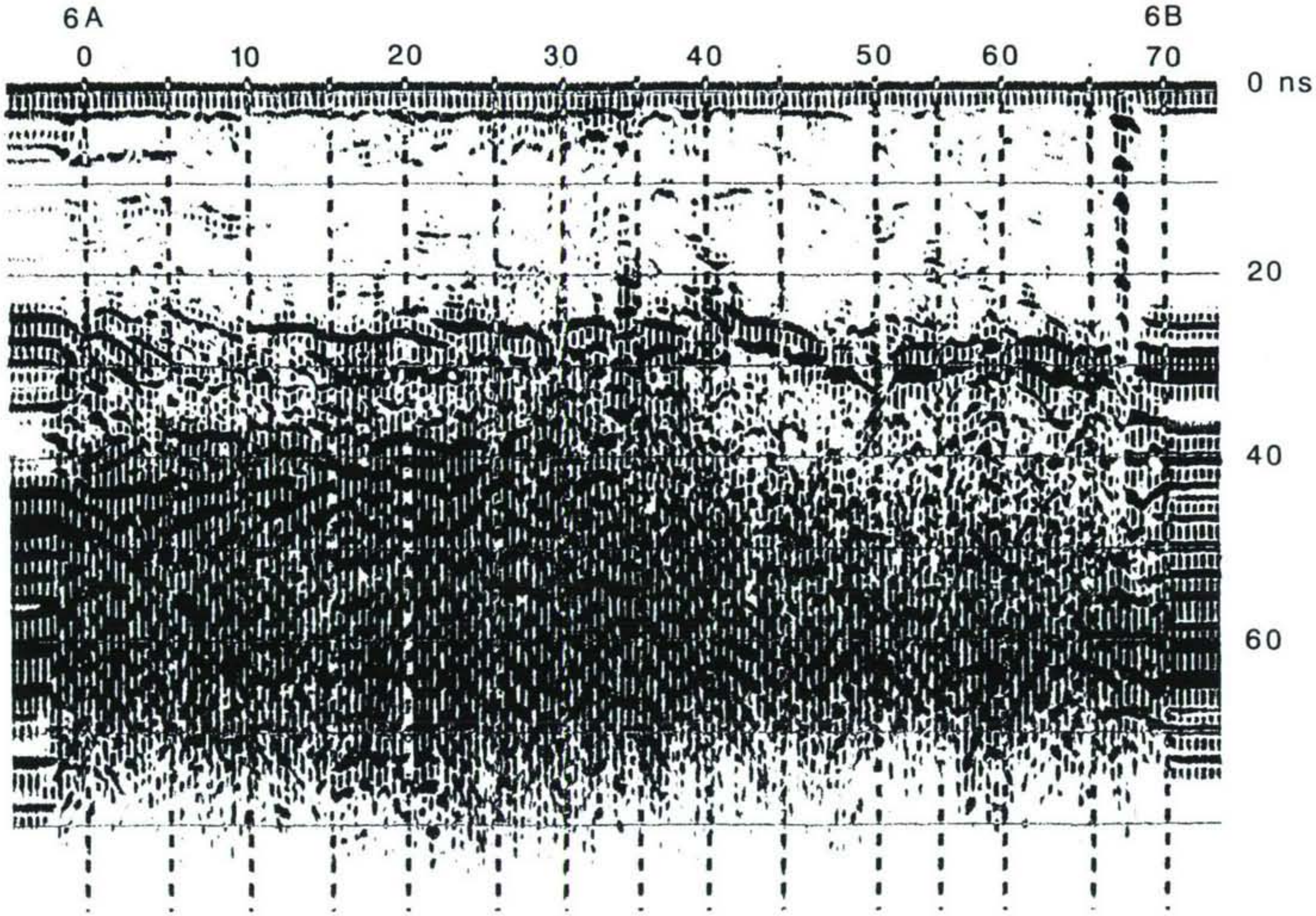
A1 STUDY AREA - LINE GPR-4 (900 MHz ANTENNA)



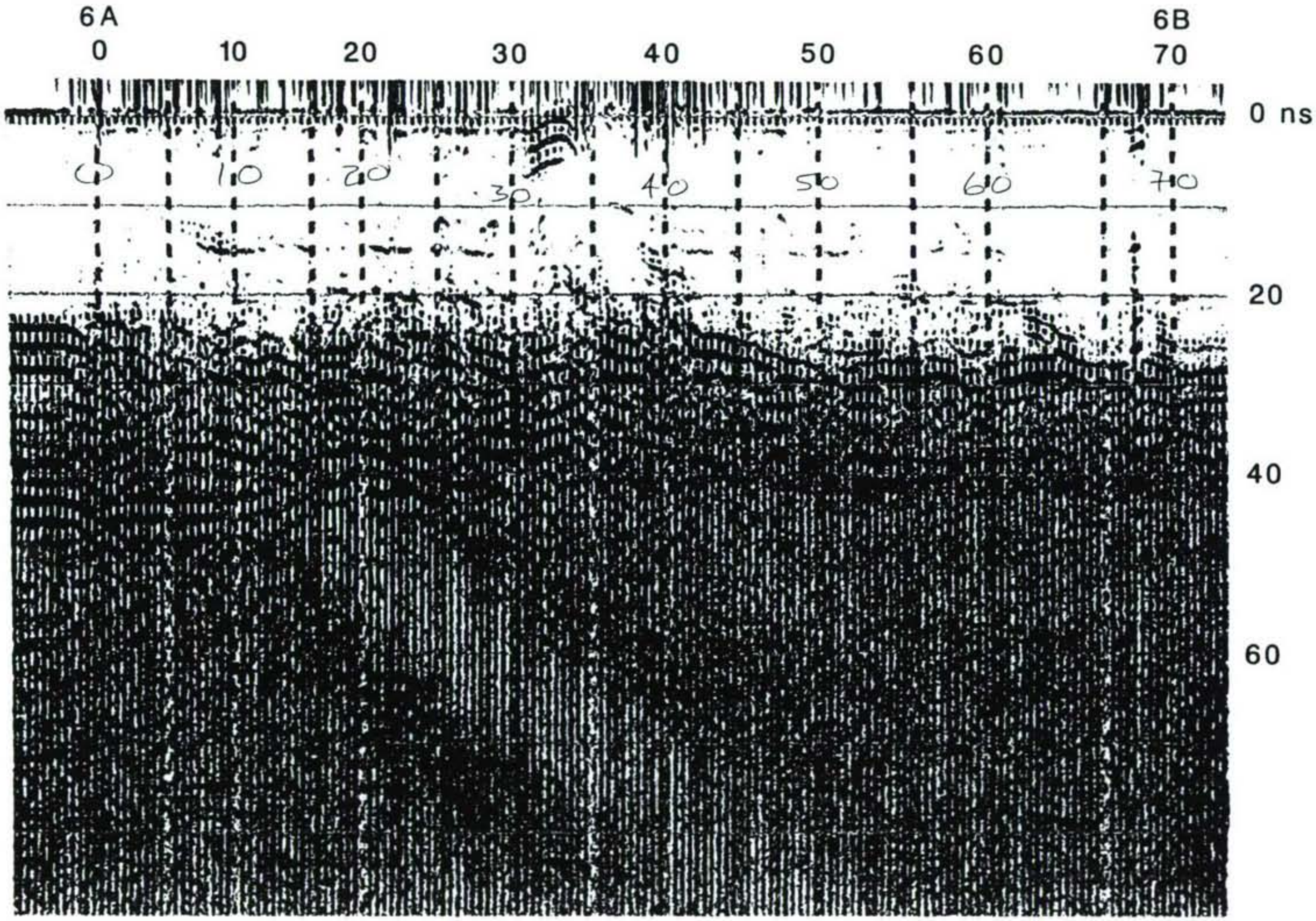
A1 STUDY AREA - LINE GPR-5 (500 MHz ANTENNA)



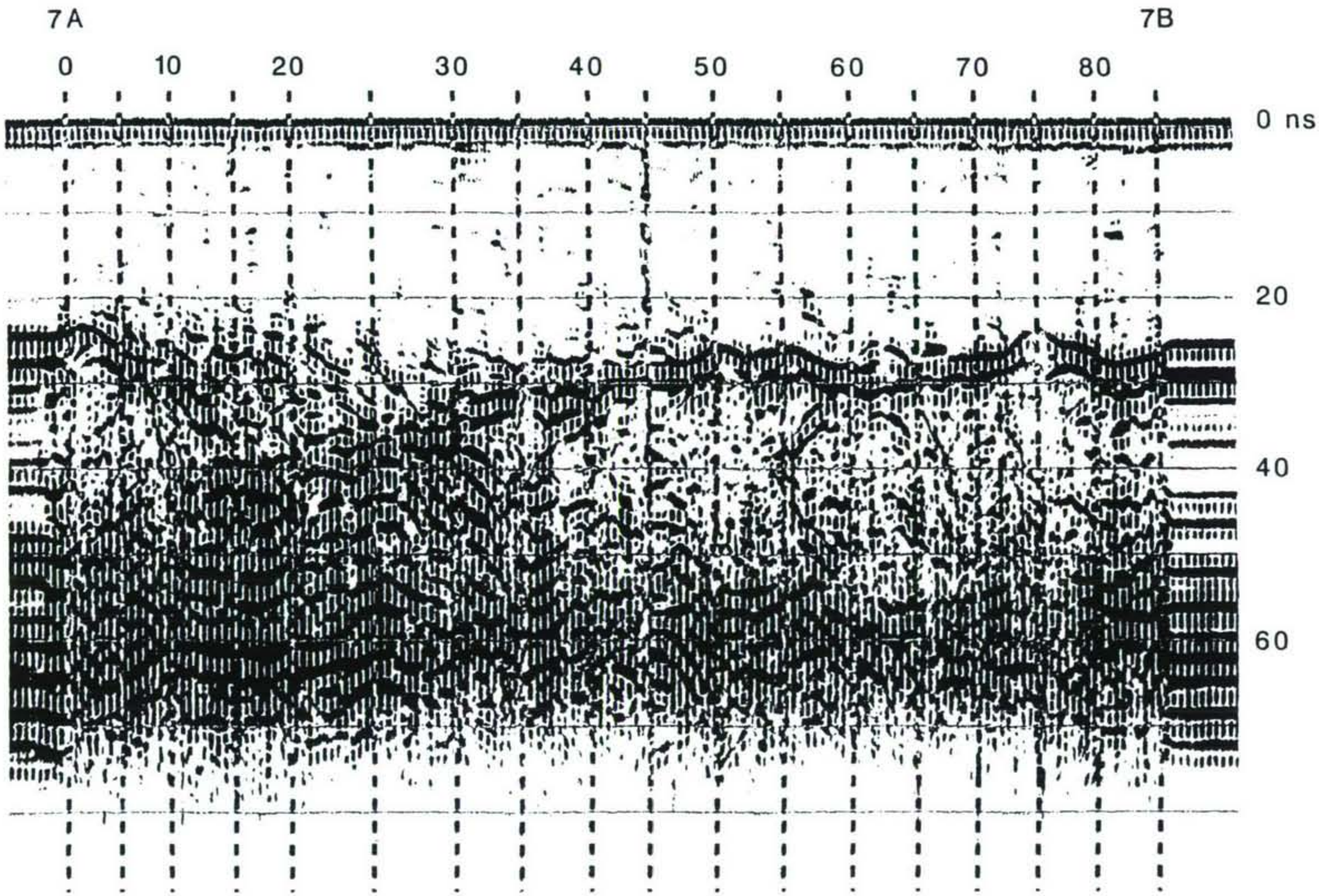
A1 STUDY AREA - LINE GPR-5 (900 MHz ANTENNA)



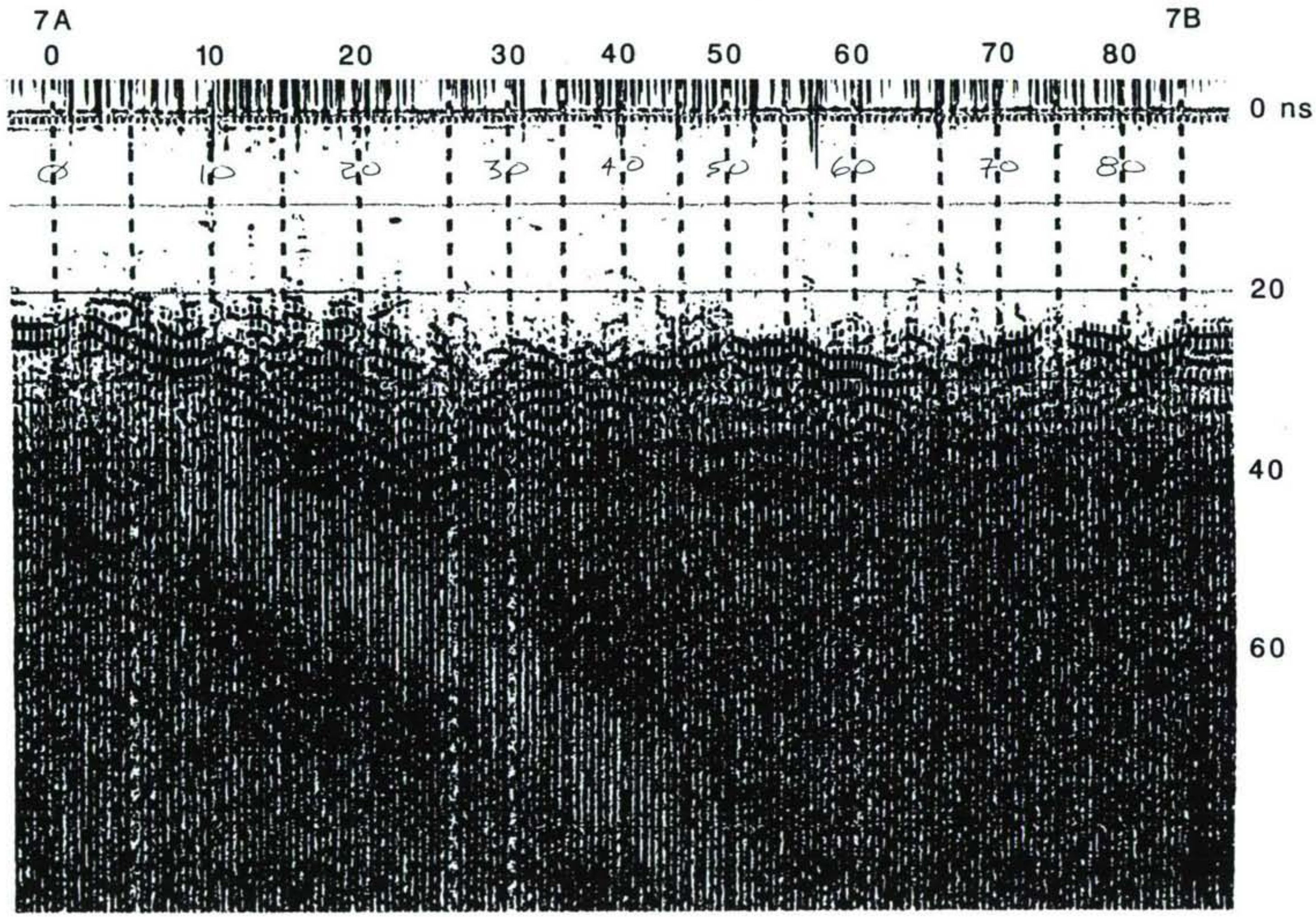
A1 STUDY AREA - LINE GPR-6 (500 MHz ANTENNA)



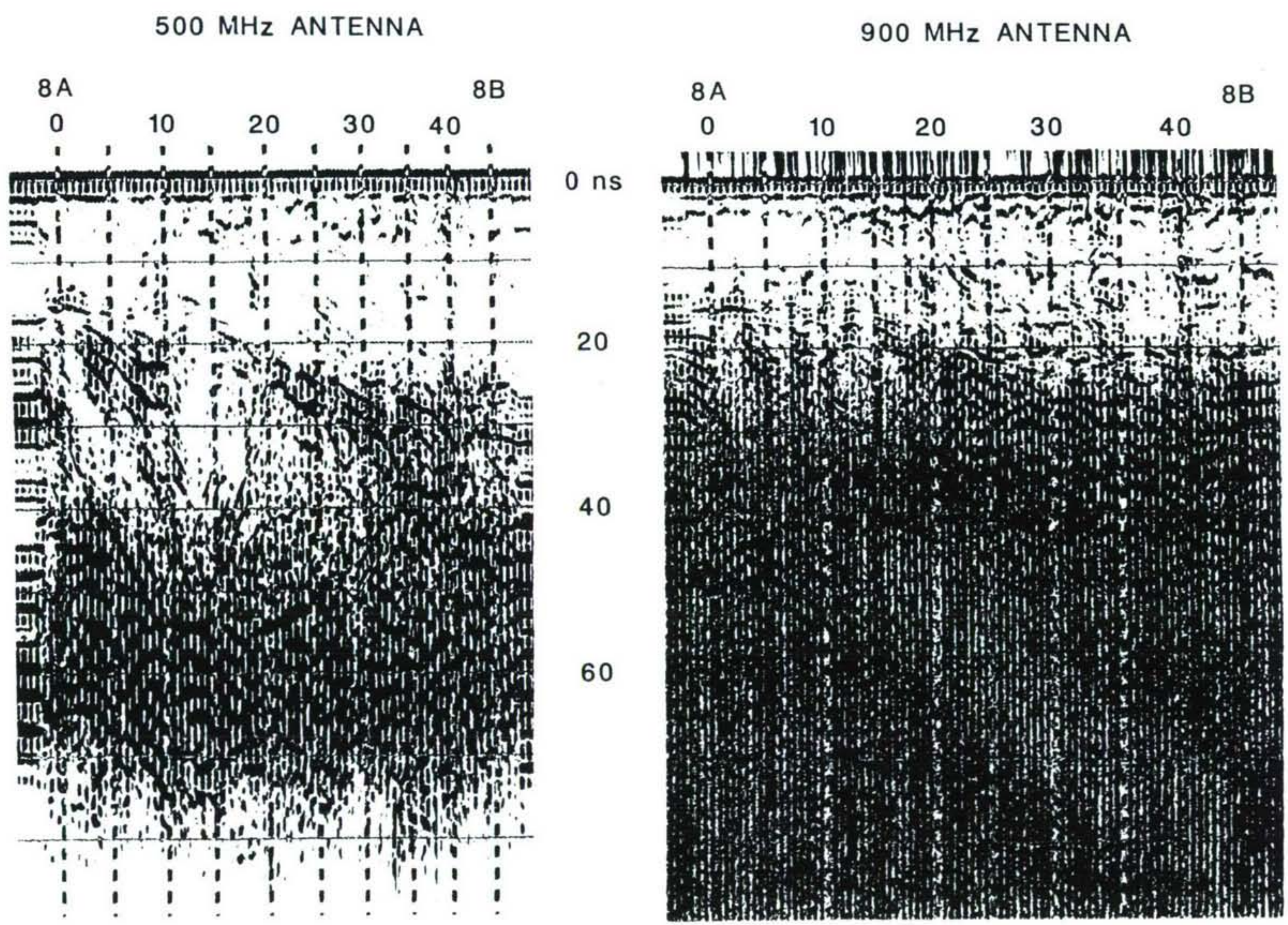
A1 STUDY AREA - LINE GPR-6 (900 MHz ANTENNA)



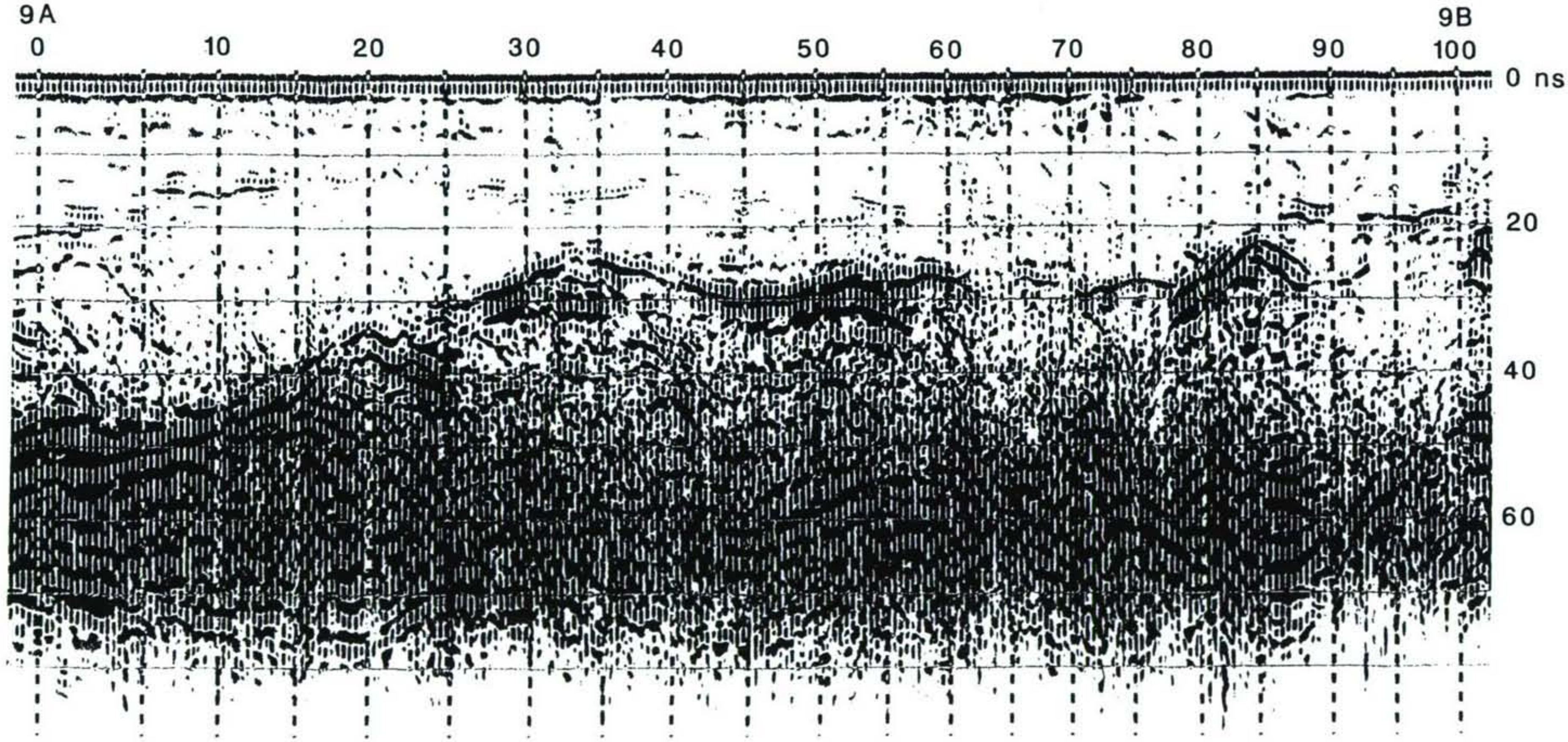
A1 STUDY AREA - LINE GPR-7 (500 MHz ANTENNA)



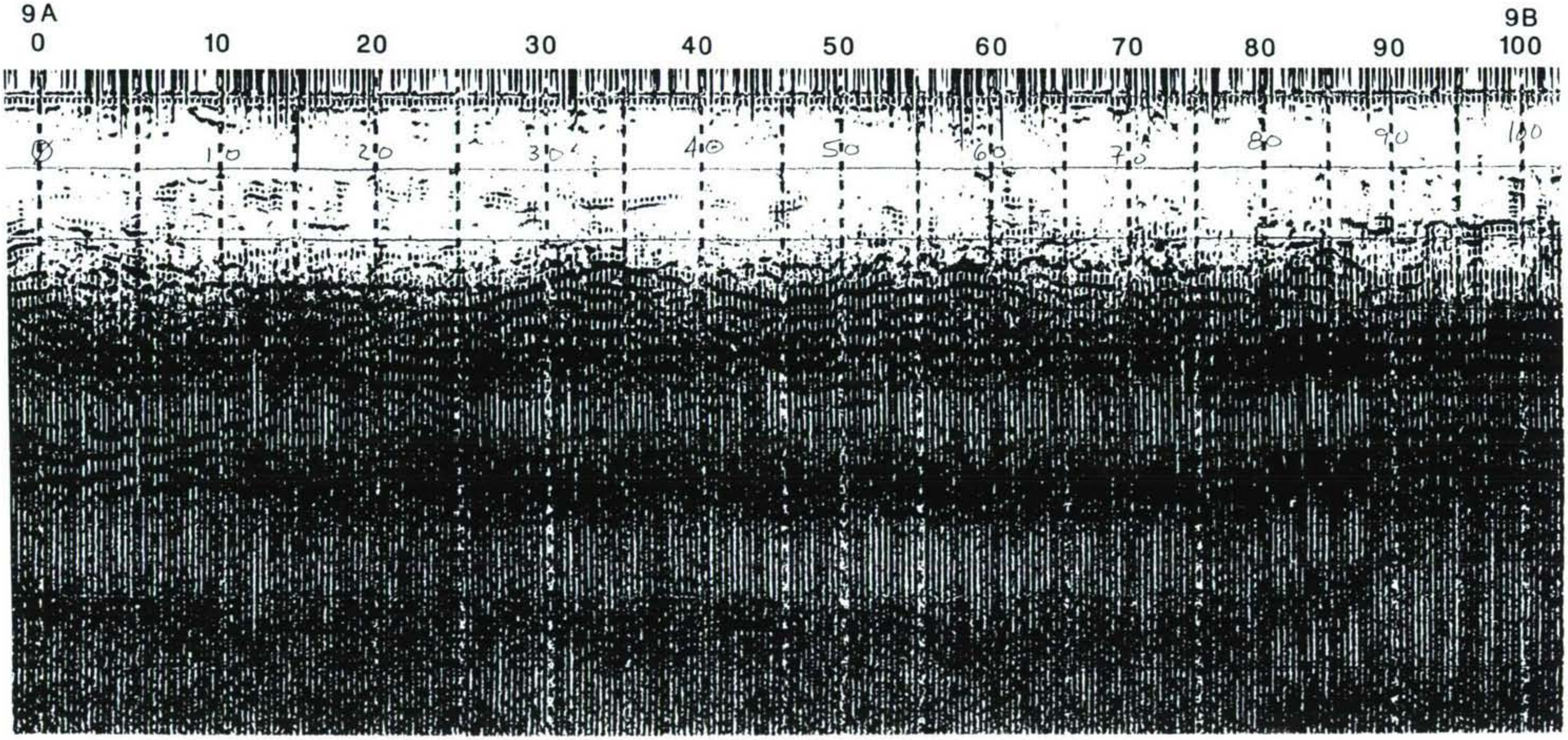
A1 STUDY AREA - LINE GPR-7 (900 MHz ANTENNA)



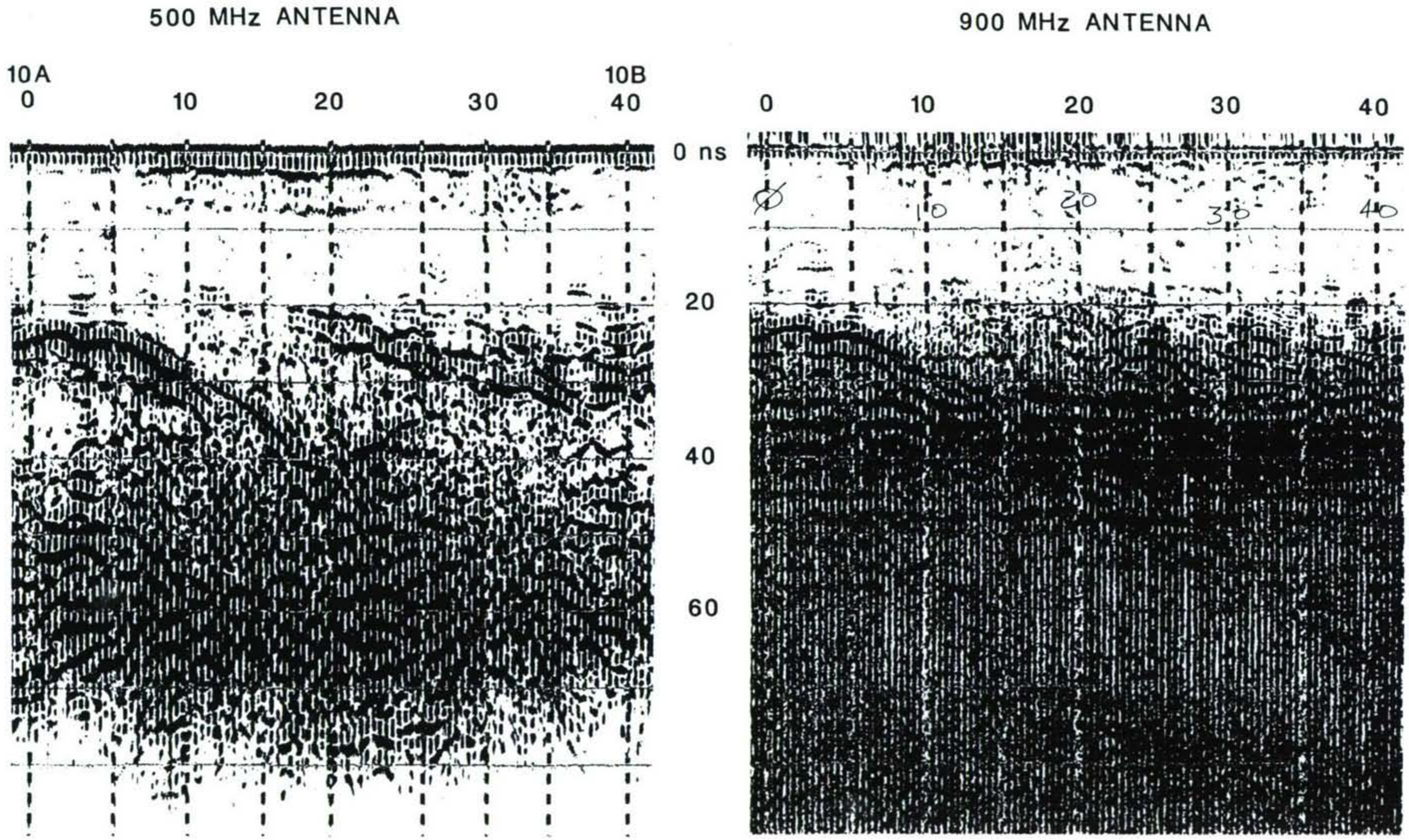
A1 STUDY AREA - LINE GPR-8



A1 STUDY AREA - LINE GPR-9 (500 MHz ANTENNA)



A1 STUDY AREA - LINE GPR-9 (900 MHz ANTENNA)



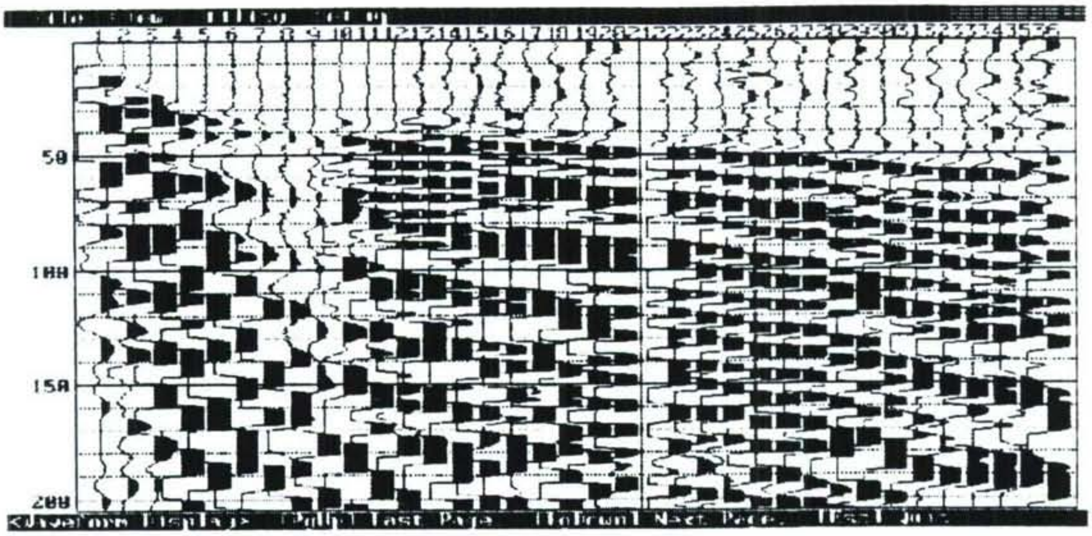
A1 STUDY AREA - LINE GPR-10

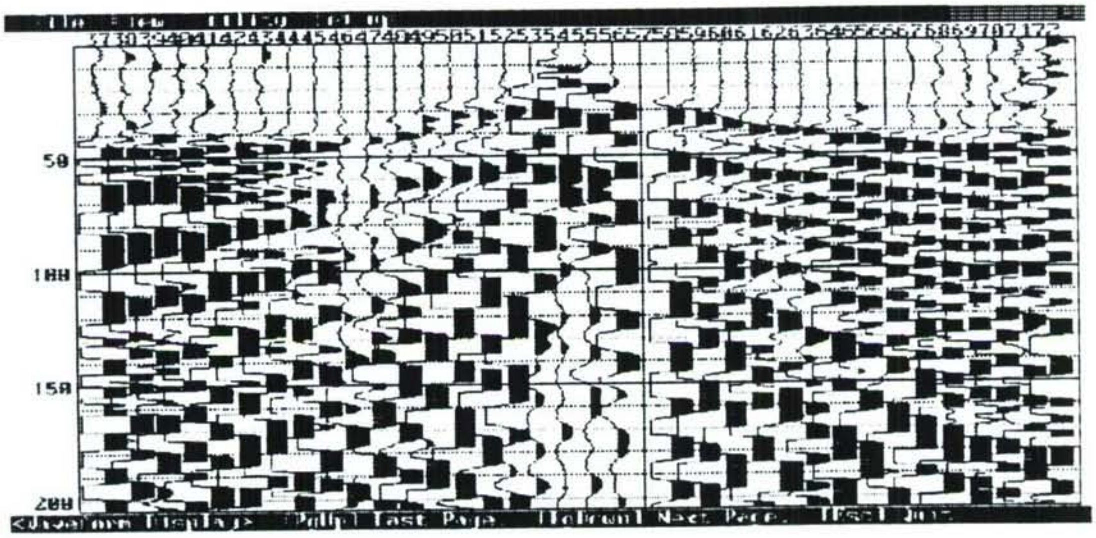
APPENDIX E

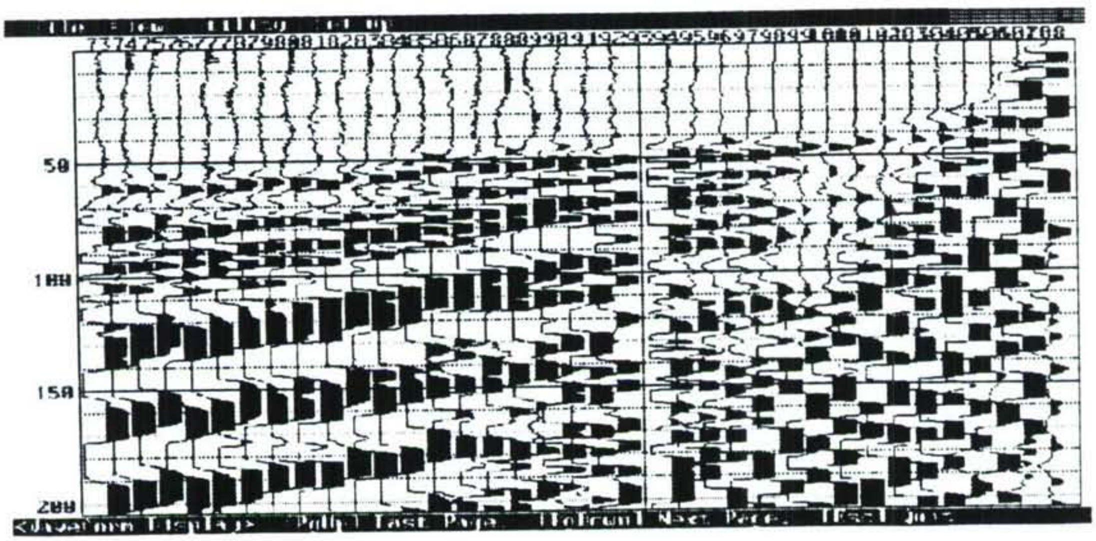
ATTACHMENT B

P11/P13 STUDY AREAS SEISMIC DATA

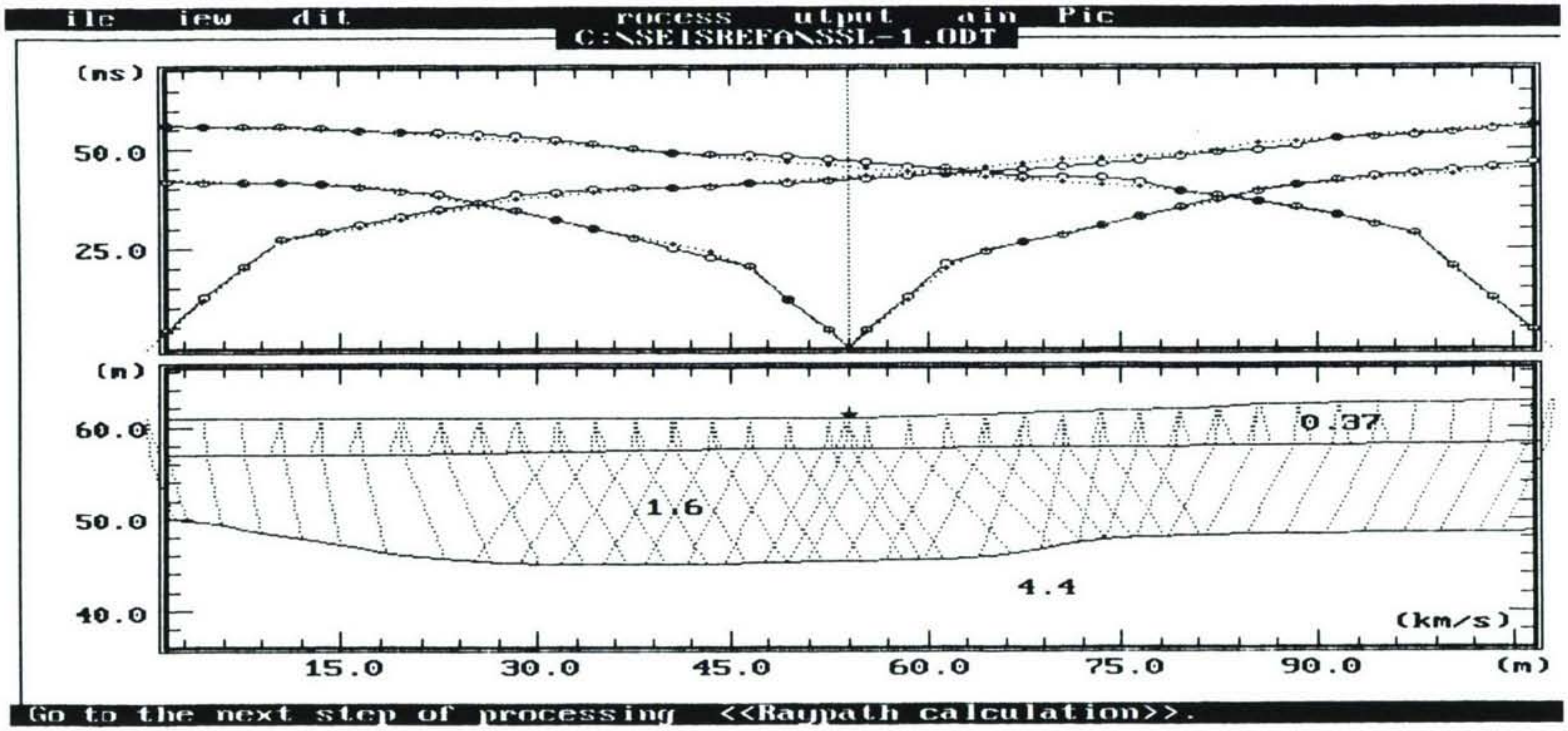
SSL-1





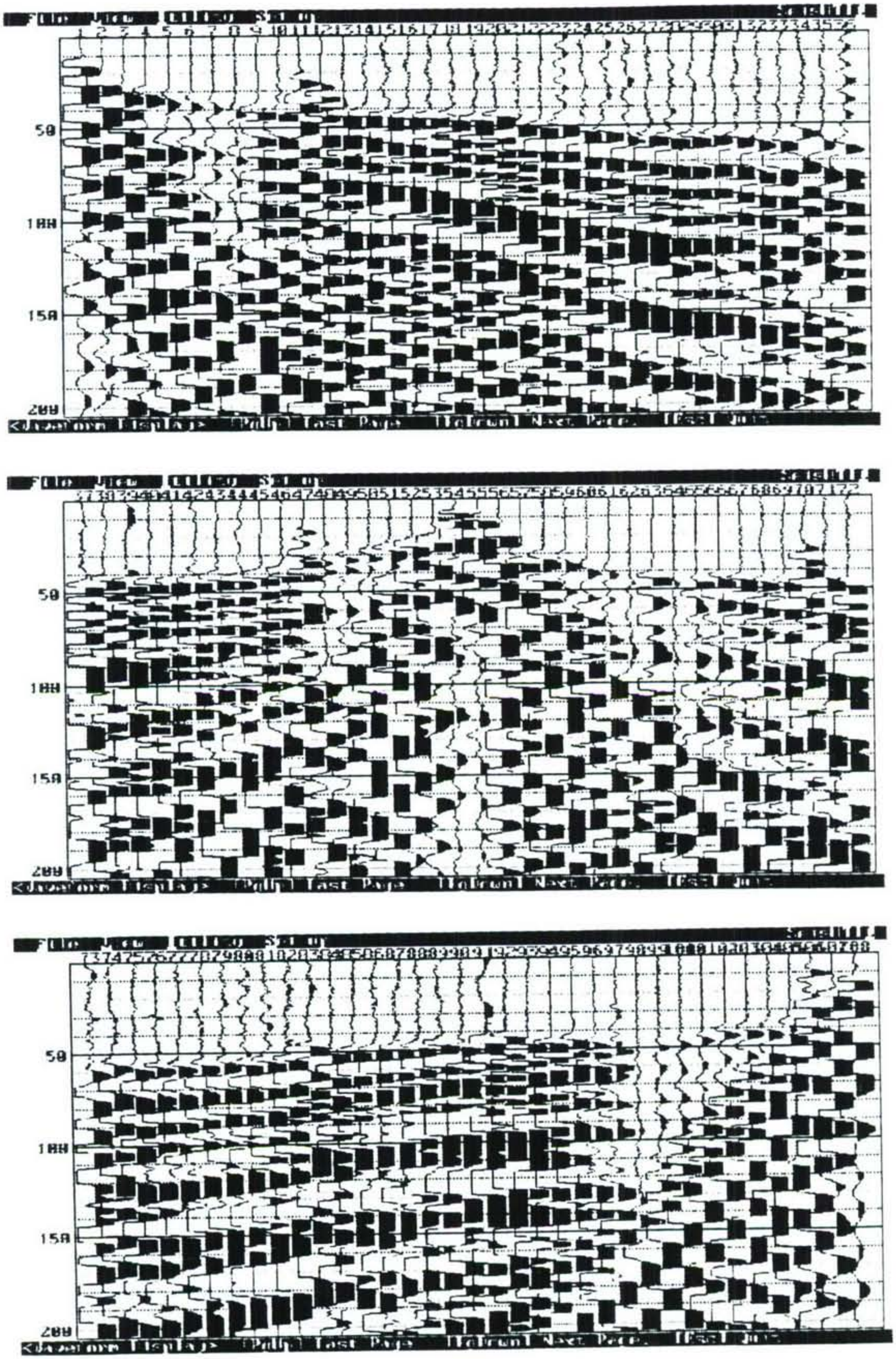


P11/P13 STUDY AREA - SEISMIC LINE SSL-1

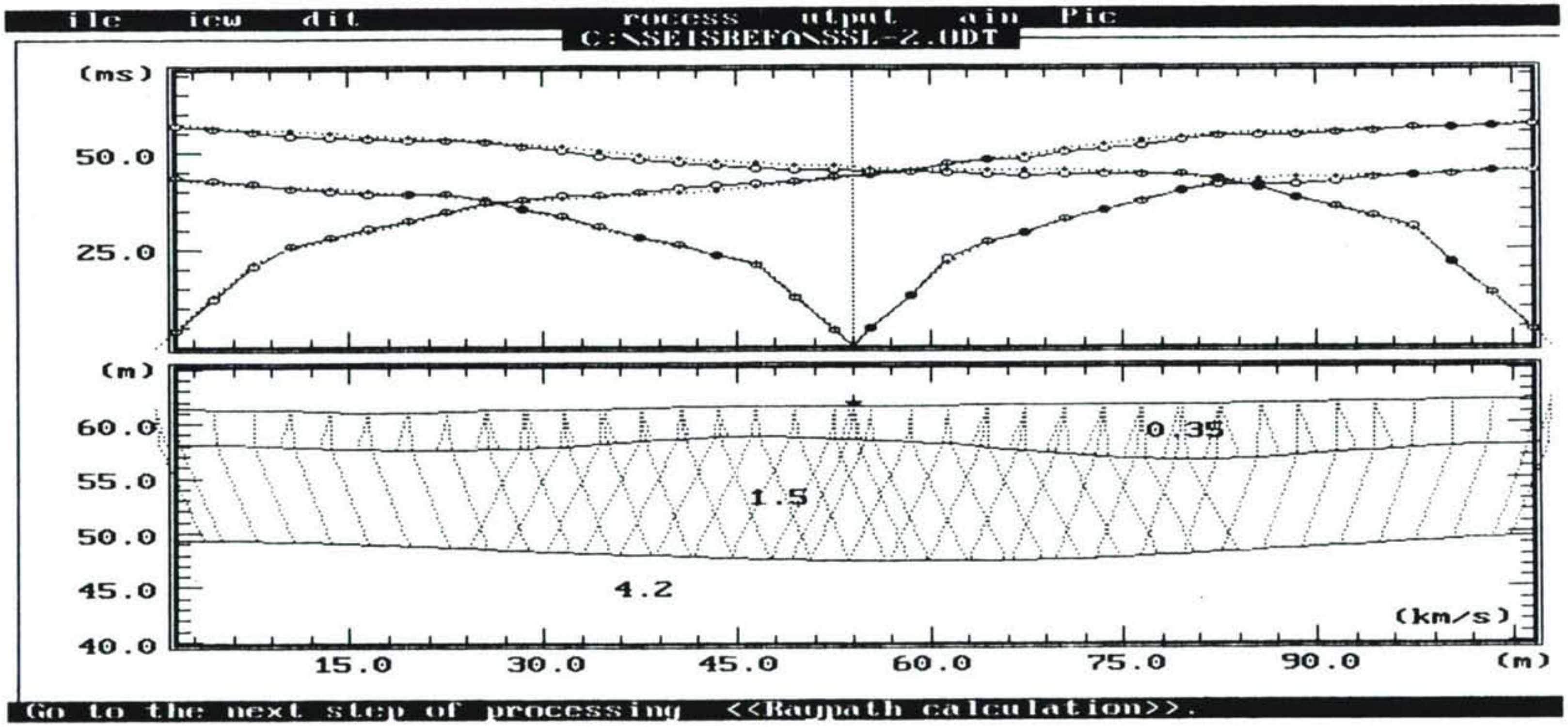


P11/P13 STUDY AREA - SEISMIC LINE SSL-1

SSL-2

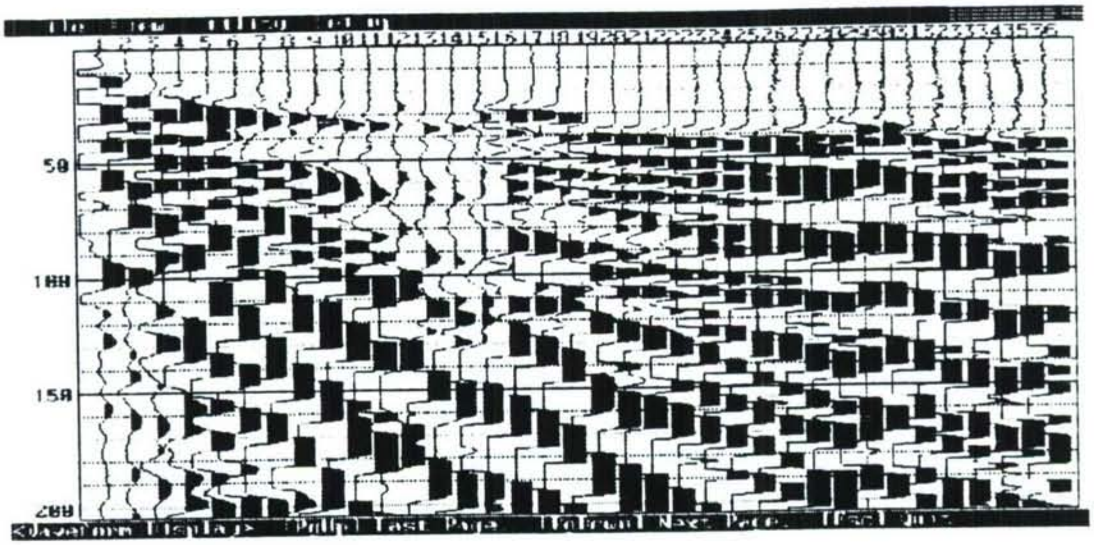


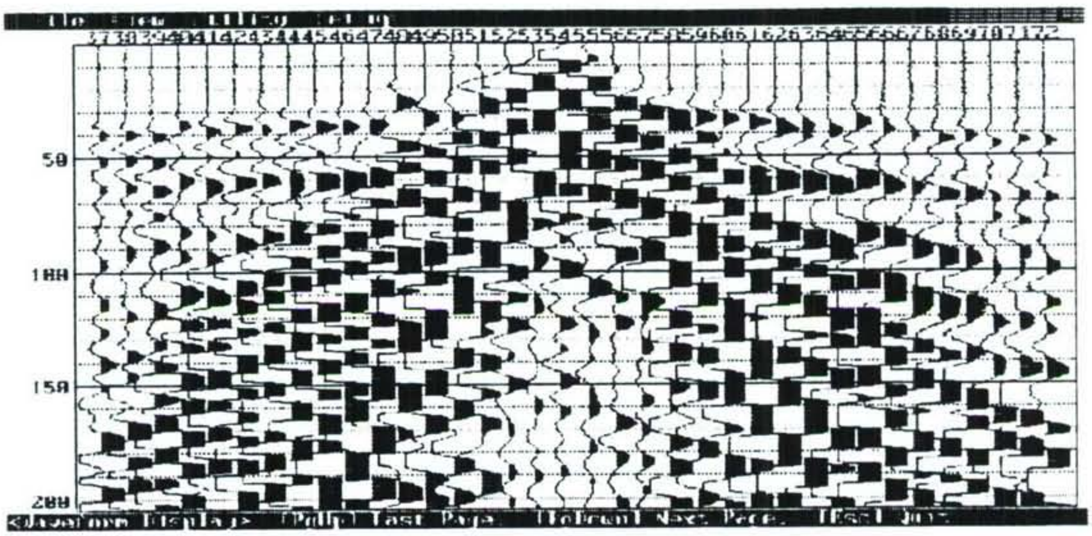
P11/P13 STUDY AREA - SEISMIC LINE SSL-2

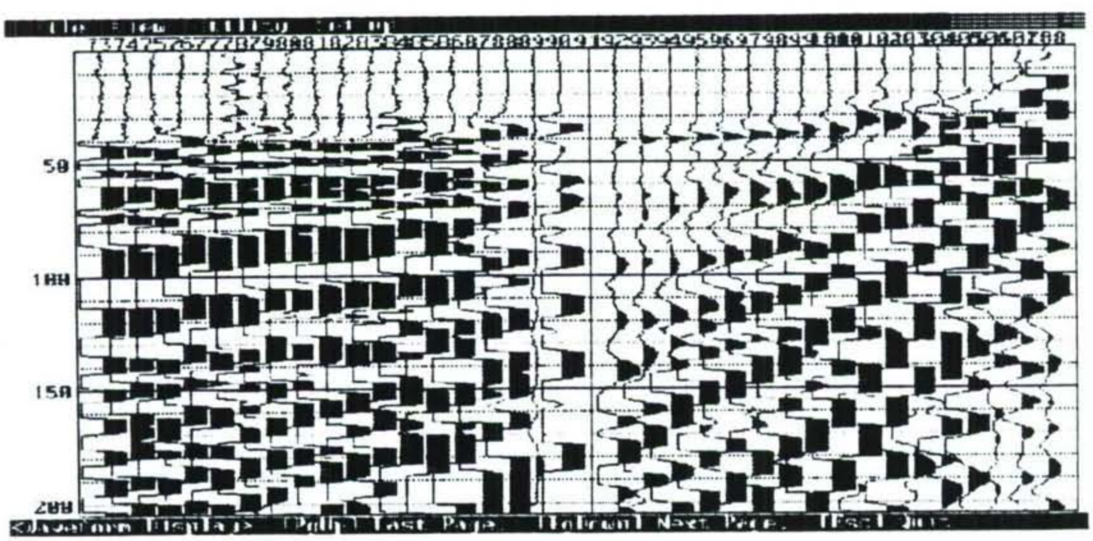


P11/P13 STUDY AREA - SEISMIC LINE SSL-2

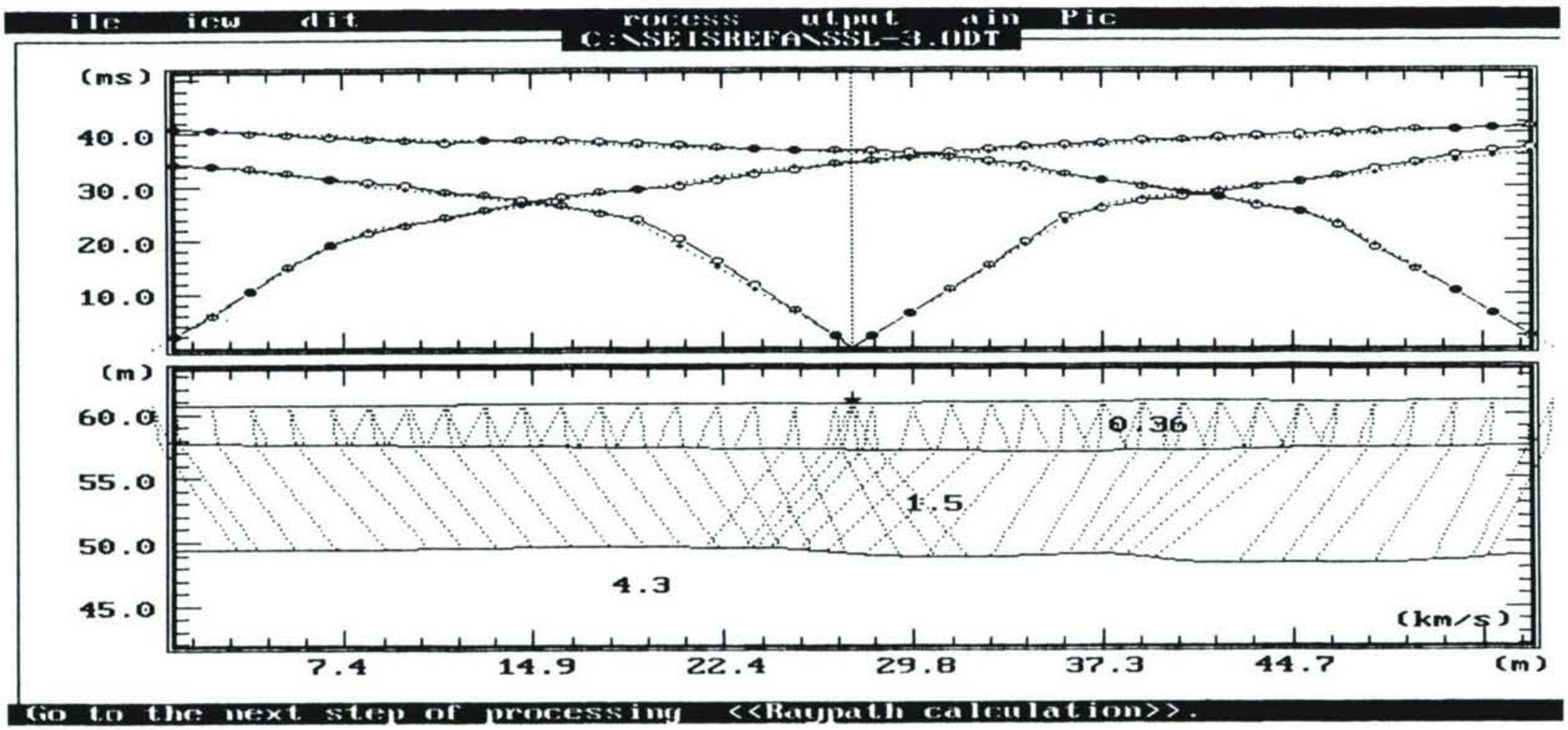
SSL-3





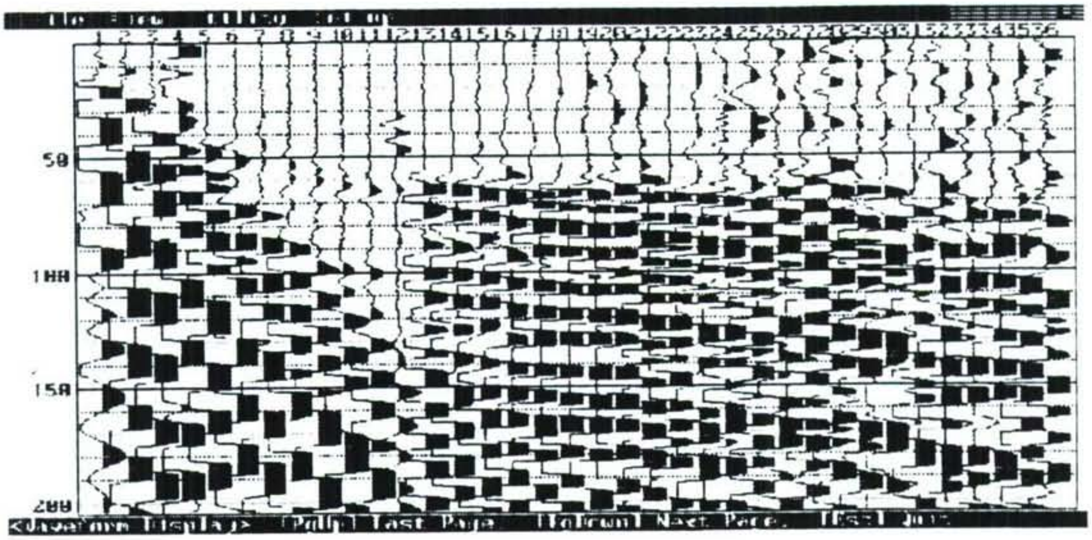


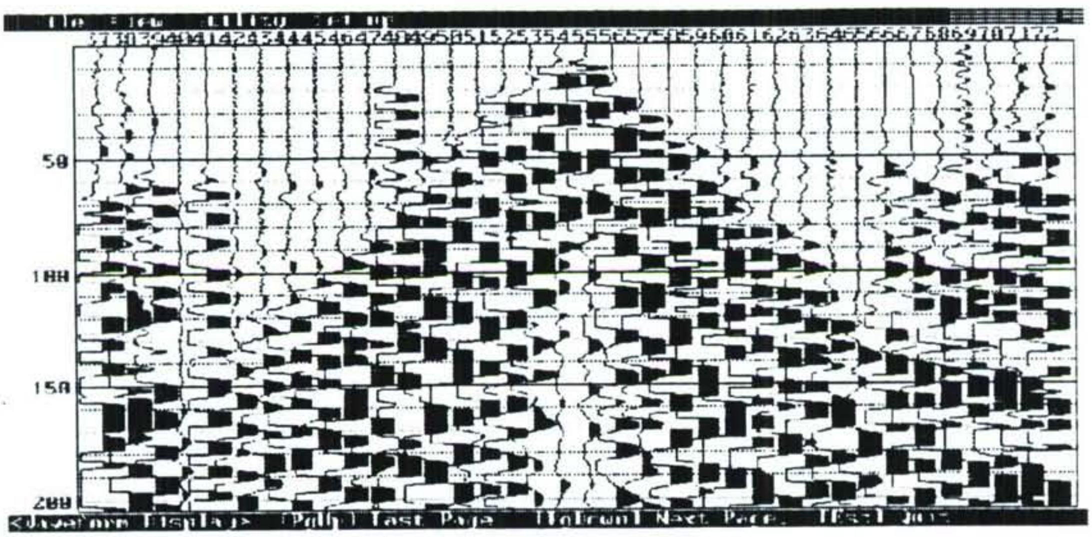
P11/P13 STUDY AREA – SEISMIC LINE SSL-3

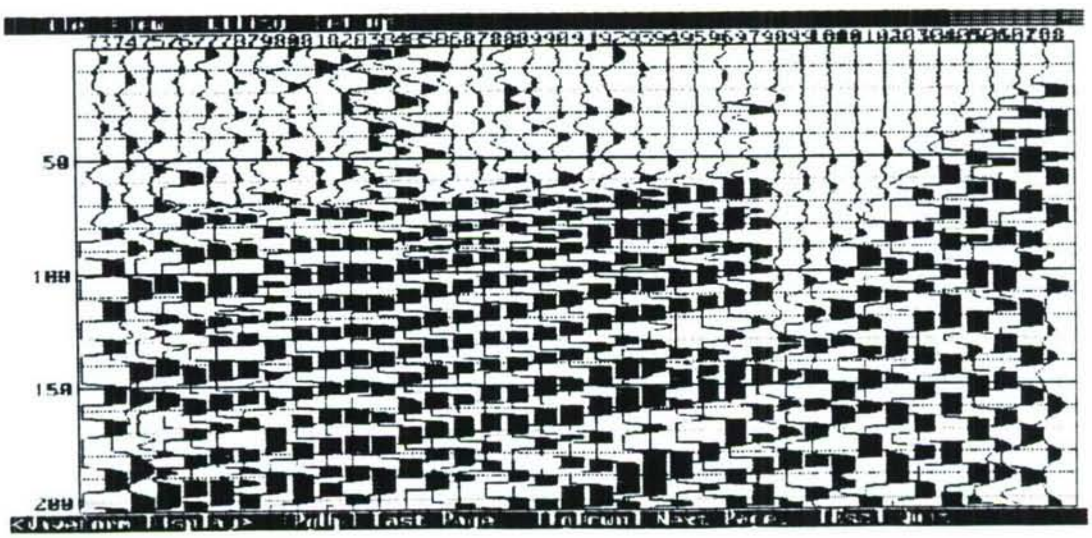


P11/P13 STUDY AREA – SEISMIC LINE SSL-3

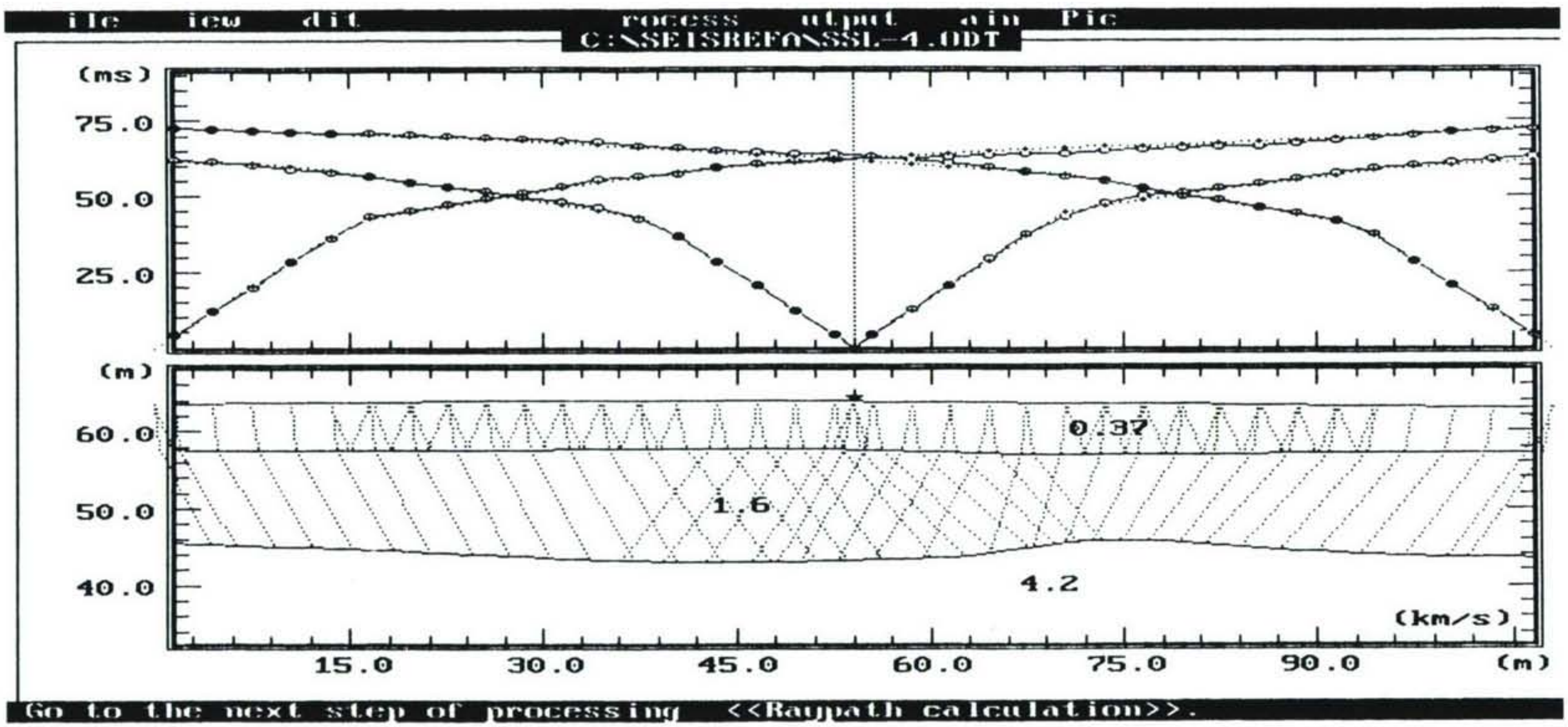
SSL-4





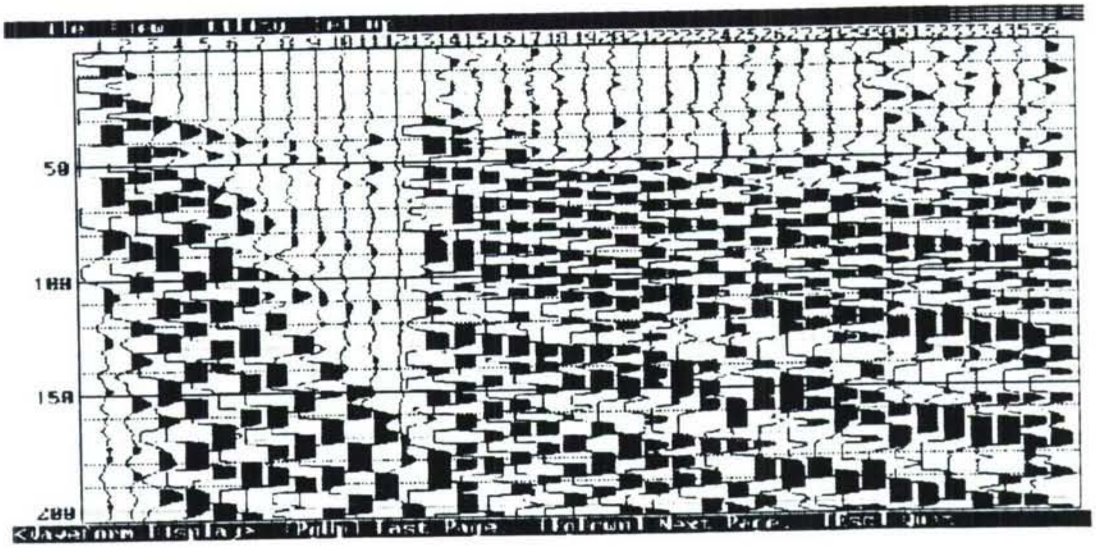


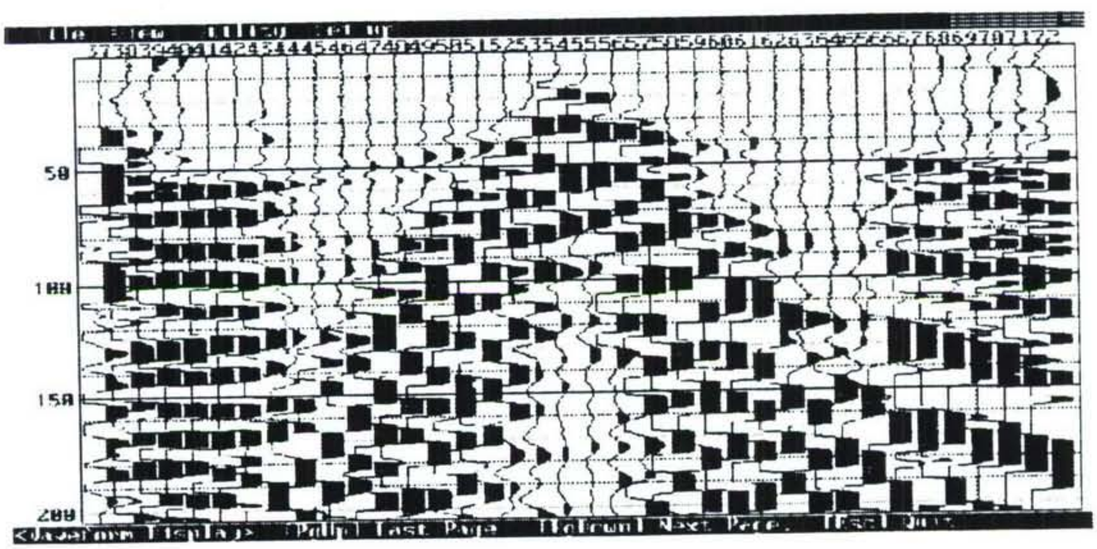
P11/P13 STUDY AREA - SEISMIC LINE SSL-4

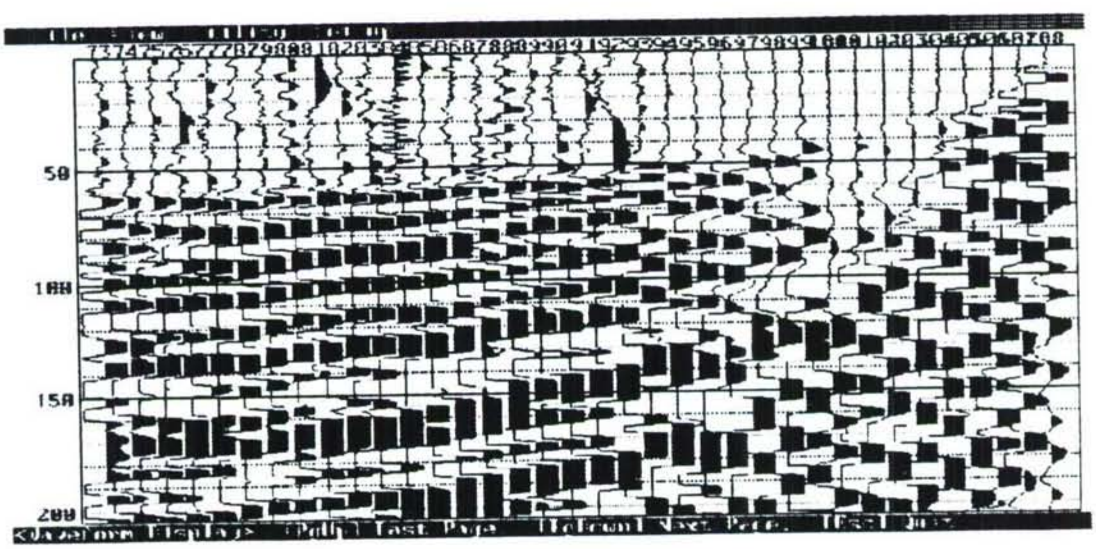


P11/P13 STUDY AREA - SEISMIC LINE SSL-4

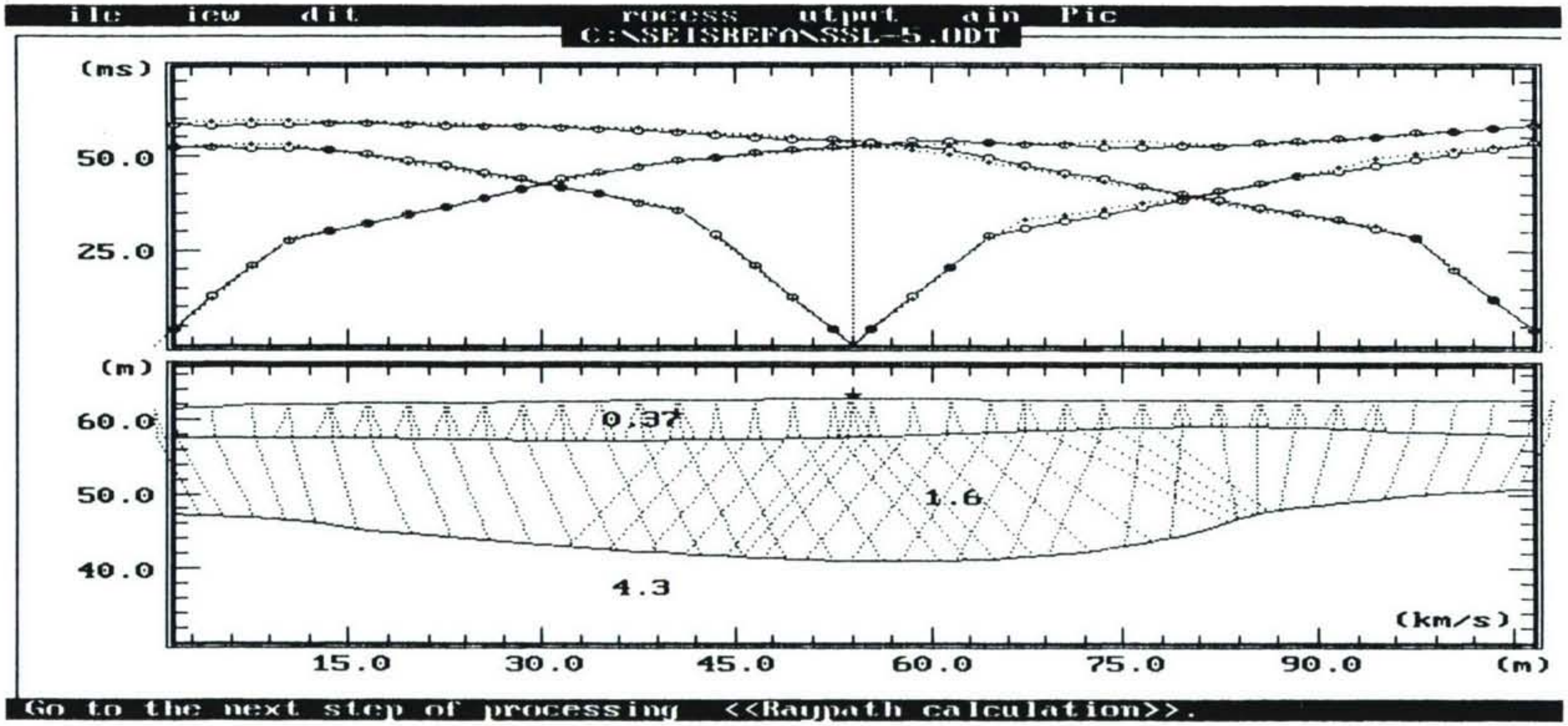
SSL-5





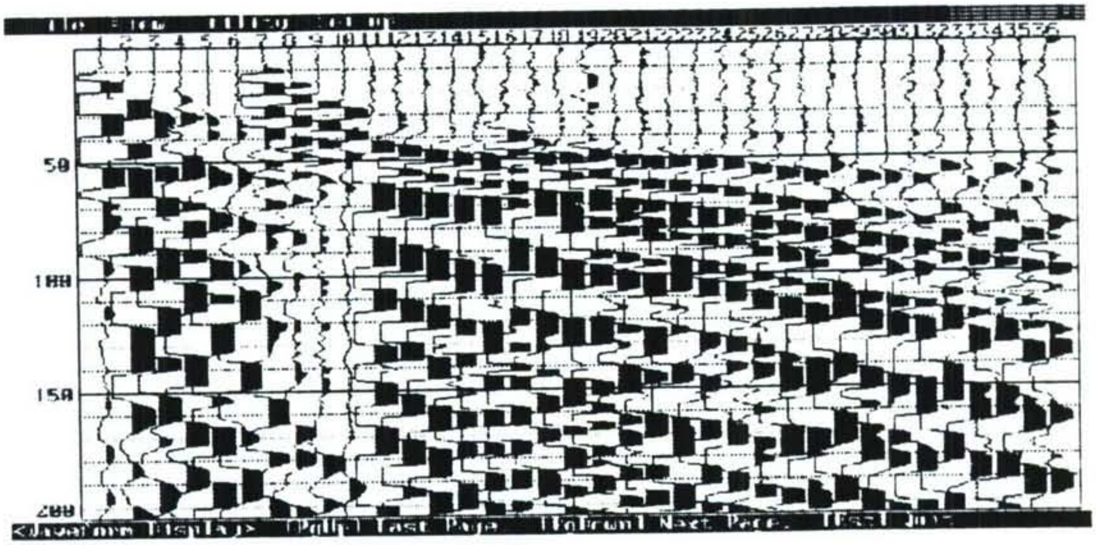


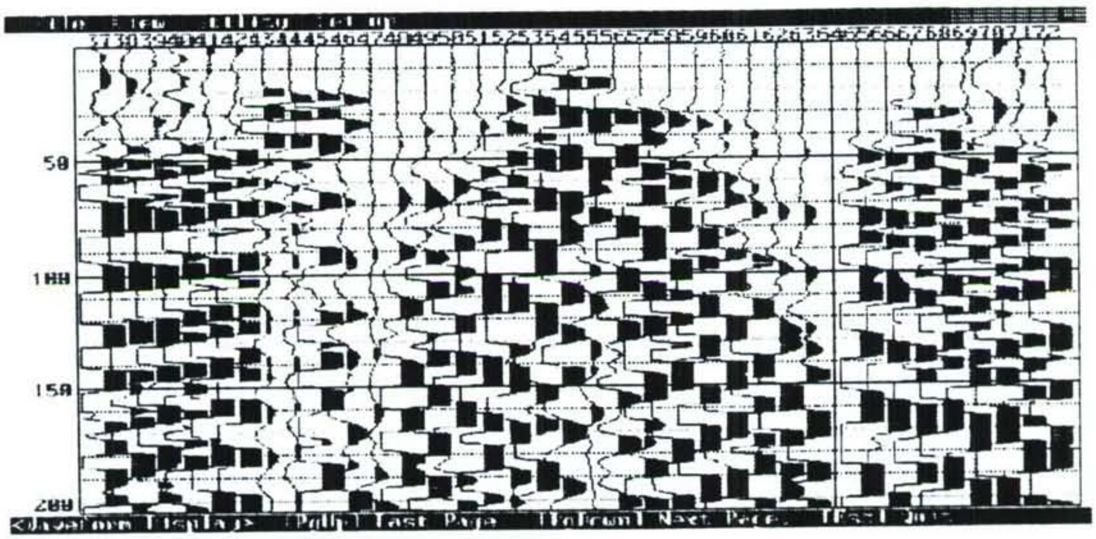
P11/P13 STUDY AREA – SEISMIC LINE SSL-5

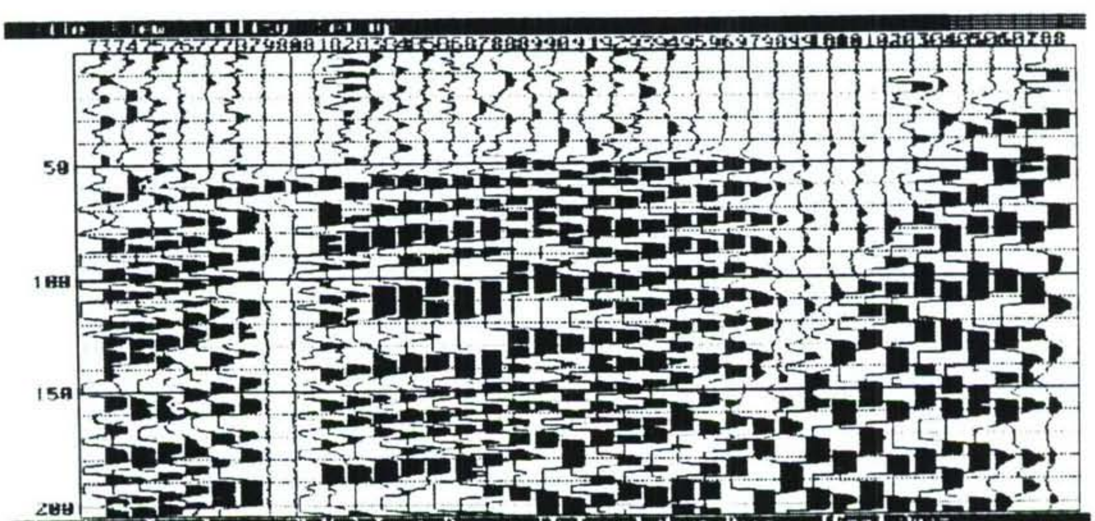


P11/P13 STUDY AREA - SEISMIC LINE SSL-5

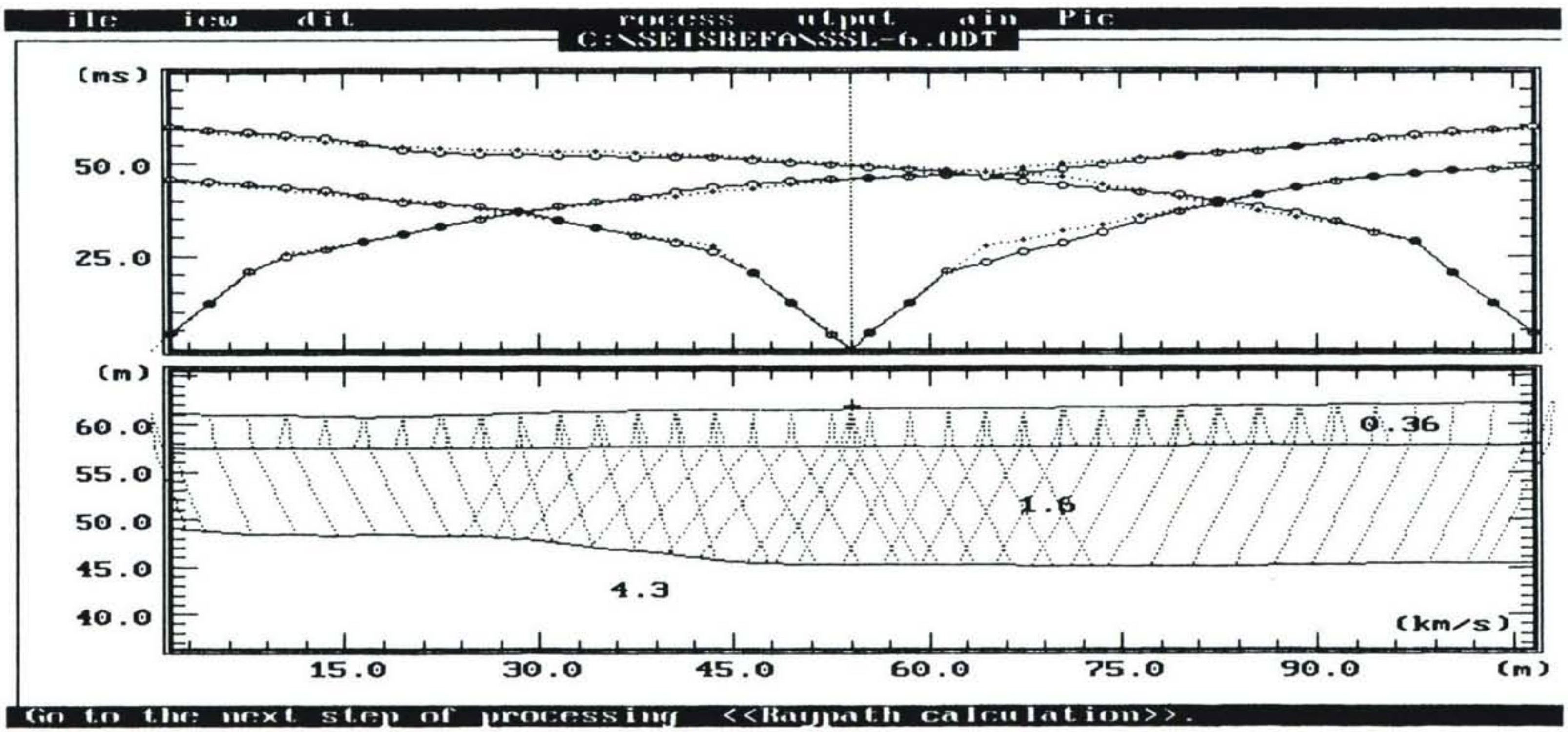
SSL-6





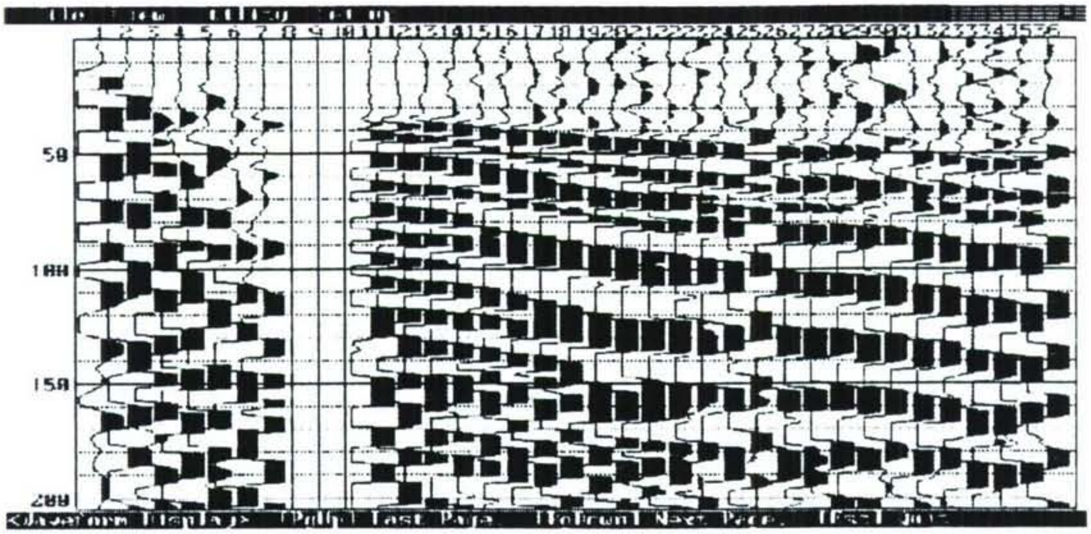


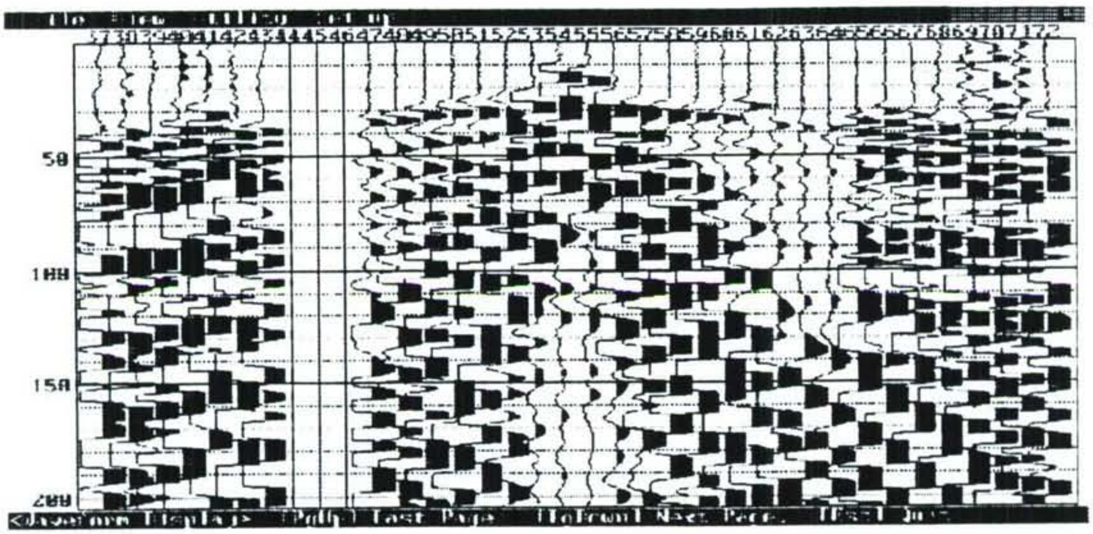
P11/P13 STUDY AREA - SEISMIC LINE SSL-6

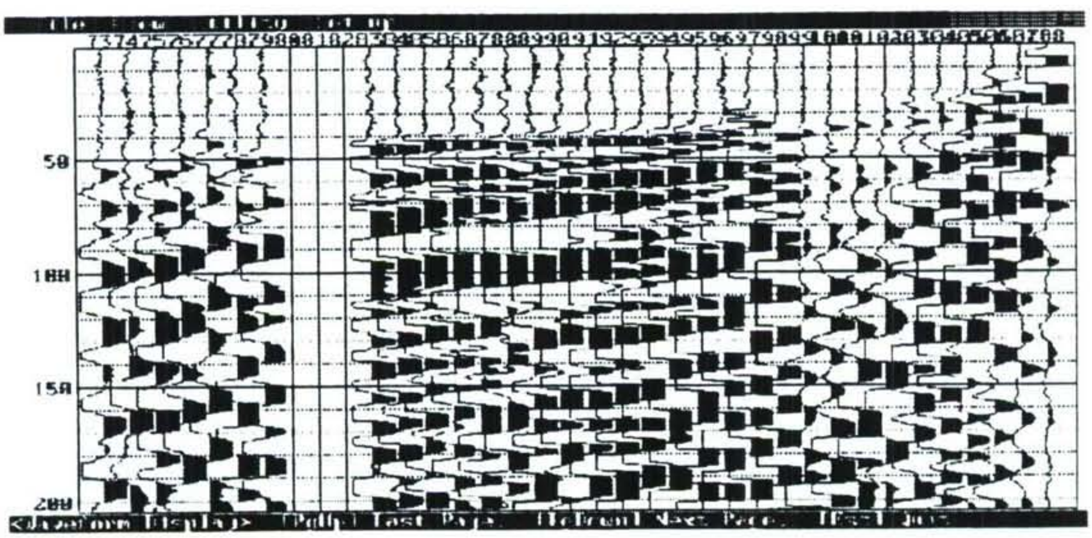


P11/P13 STUDY AREA - SEISMIC LINE SSL-6

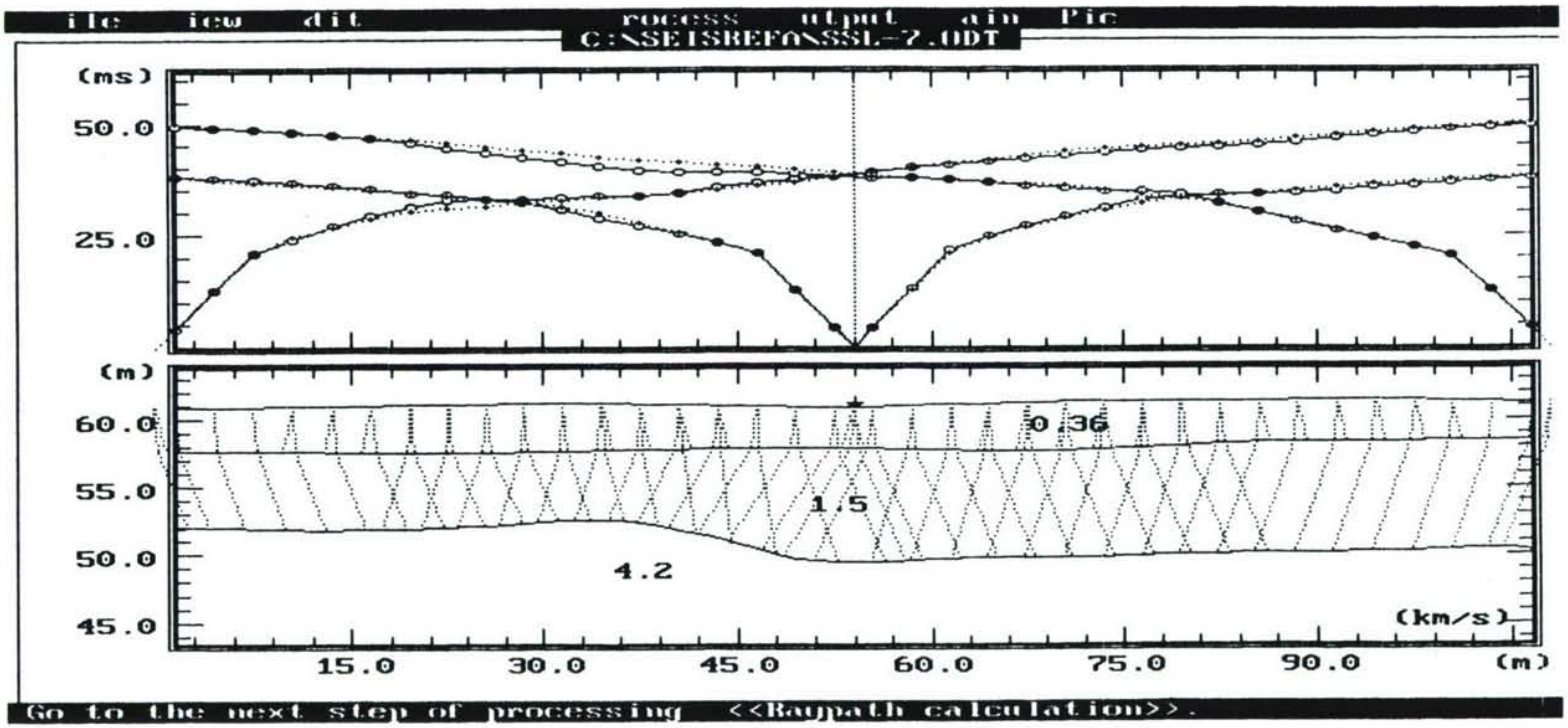
SSL-7





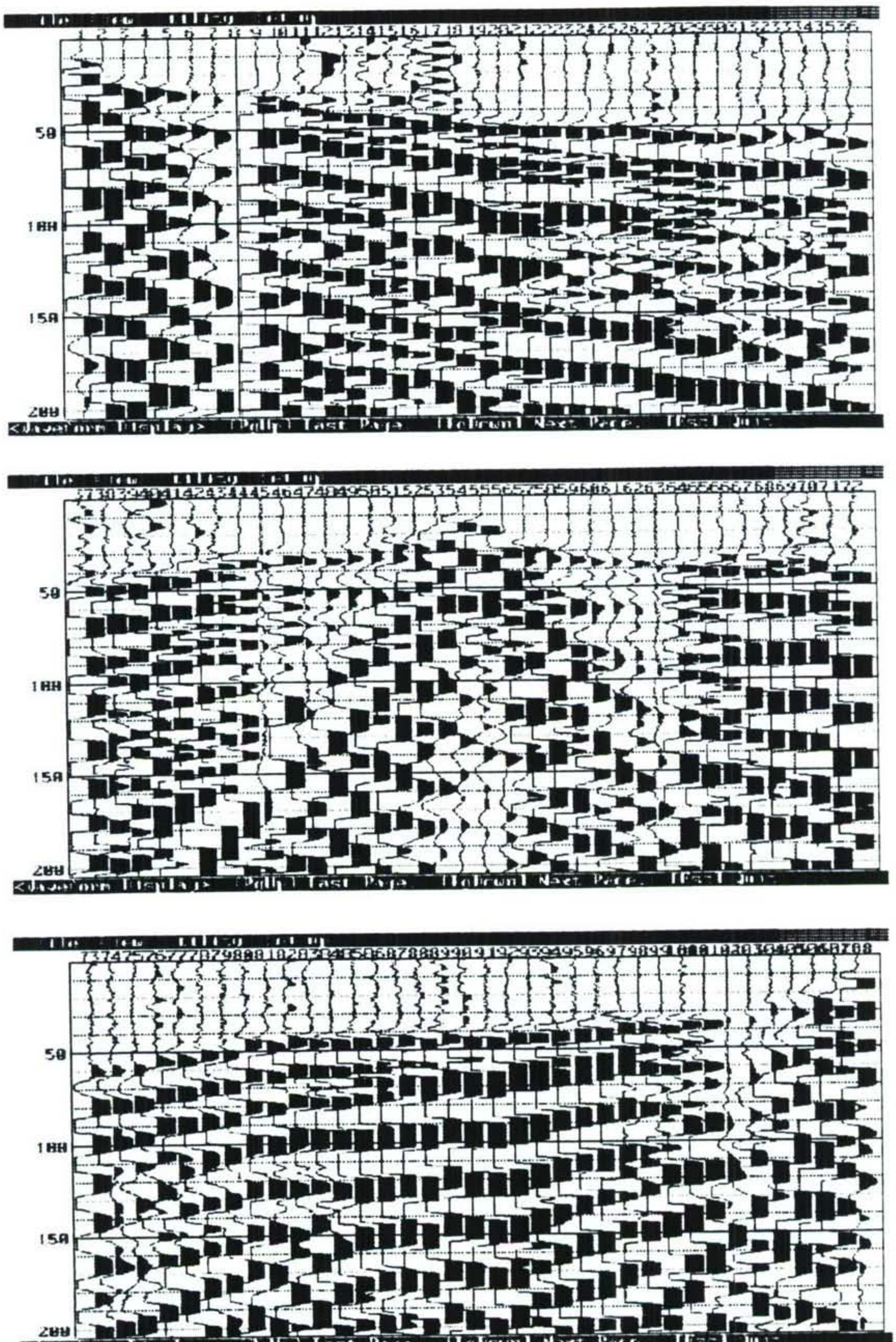


P11/P13 STUDY AREA - SEISMIC LINE SSL-7

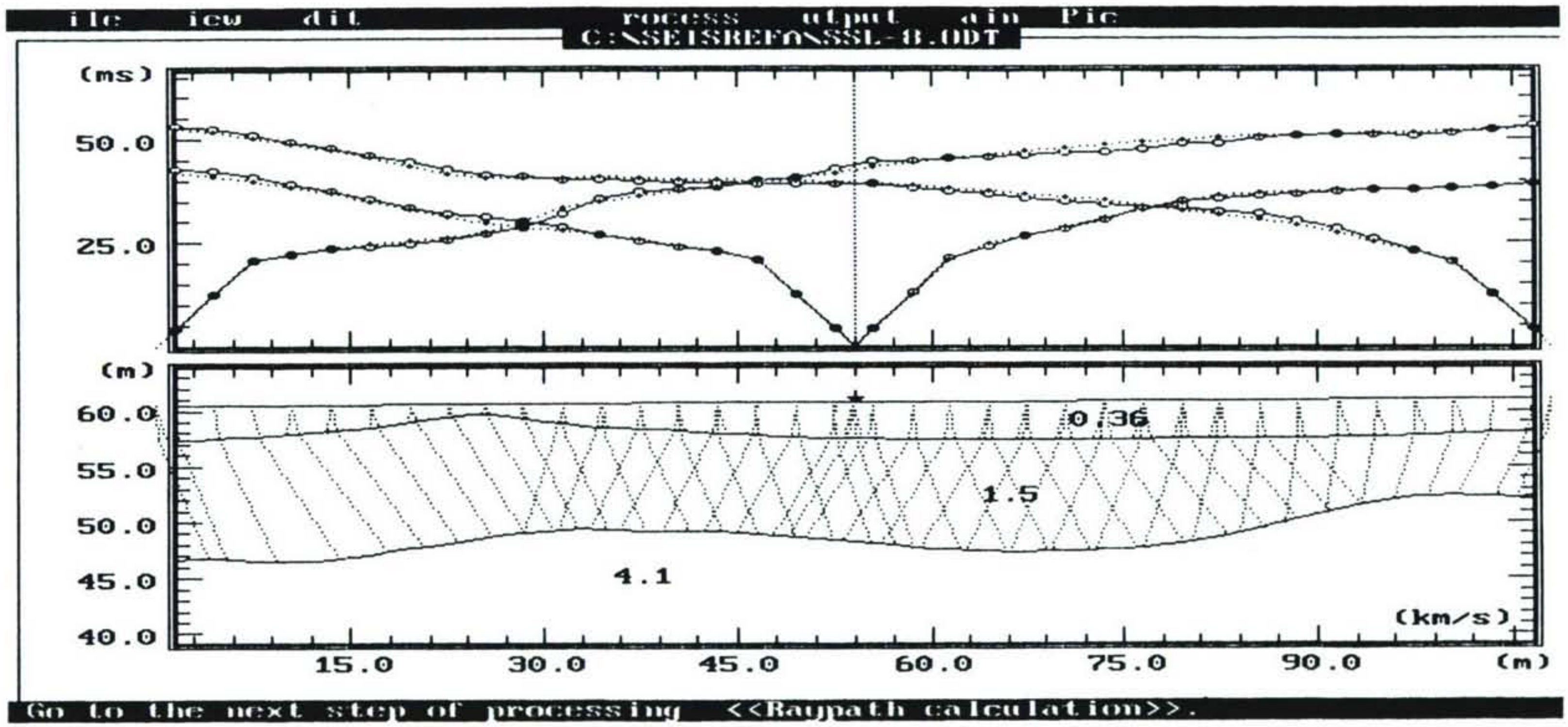


P11/P13 STUDY AREA - SEISMIC LINE SSL-7

SSL-8



P11/P13 STUDY AREA – SEISMIC LINE SSL-8



P11/P13 STUDY AREA - SEISMIC LINE SSL-8

APPENDIX E

ATTACHMENT C

P13 STUDY AREA
RAW EM & MAG DATA

UC6Ø61 8-11-93 UC6Ø61 8-11-93

Station N	Station E	V-Dipole N-S	V-Dipole E-W	H-Dipole N-S	H-Dipole E-W	Magnetometer Readings	Comments
1+40	1+40	3.0	2.7	2.9	3.0	54537	
+60	"	3.2	3.0	2.6	3.1	54532	
+80	"	3.2	3.2	3.0	3.0	54531	
2+00	"	3.3	3.4	3.3	3.3	54529	
+20	"	3.4	3.4	3.3	3.4	54528	Stressed Veg (?) @ N2+10
+40	"	3.7	3.4	3.4	3.4	54528	
+60	"	4.0	3.5	3.4	3.2	54519	Stressed Veg (?) @ N2+57
+80	"	3.8	3.8	3.6	3.3	54514	
3+00	"	4.8	4.4	3.8	3.6	54513	
1+00	1+00	—	—	—	—	54495.5	12:26, Base Station
1+00	1+00	—	—	—	—	54508.0	13:51, Base Station
Ø+80	1+60	5.2	4.8	5.0	4.9	54527	
1+00	"	5.3	5.0	5.3	5.4	54551	
+20	"	5.0	5.1	5.2	5.0	54546	
+40	"	5.1	5.2	5.2	5.3	54544	
+60	"	5.2	5.2	5.2	5.5	54547	
+80	"	5.4	5.3	5.4	5.5	54550	
2+00	"	5.5	5.4	5.6	5.5	54548	
+20	"	5.4	5.4	5.5	5.4	54548	
+40	"	5.4	5.1	6.0	5.5	54551	
+60	"	5.6	5.7	5.6	5.5	54543	Stressed Veg (?) @ N1+51
+80	"	6.1	6.0	6.0	5.4	54534	Manhole (?) @ N2+75, E1+69
3+00	"	6.4	6.2	5.8	5.9	54483	
1+00	1+00	—	—	—	—	54518.0	14:05, Base station
1+80	1+40	5.2	5.2	5.2	5.4	—	EM Check, 1400 ★
1+00	1+80	4.8	4.8	5.2	5.0	54557	
+20	"	5.0	4.9	5.2	5.2	54555	
+40	"	5.1	5.0	5.1	5.4	54559	

P13 STUDY AREA – EM AND MAGNETOMETER DATA, SHEET 1 of 3

UC6Ø61 P13 DATA 8-11-93 UC6Ø61 8-11-93

STATION N	STATION E	V-Dipole N-S	V-Dipole E-W	H-Dipole N-S	H-Dipole E-W	Magnetometer Reading	Comments
0+60	1+00	3.4	3.2	3.2	3.0	54499.	
+80	"	3.1	3.0	3.0	3.0	54494.	
1+00	"	3.3	3.2	3.2	3.3	54488.2	11:25, Base station
+20	"	3.3	3.2	3.0	3.2	54494	
+40	"	3.4	3.4	3.4	3.5	54511	
+60	"	3.3	3.1	3.4	3.4	54525	
+80	"	3.4	3.5	3.6	3.2	545Ø5	
2+00	"	3.5	3.2	3.2	3.4	54552	P.Pole @ N2+00, E 1+05
+20	"	3.5	3.5	3.8	3.6	54553	
+40	"	3.7	3.6	3.8	3.4	54473	
+60	"	4.0	4.0	3.8	3.5	54477	
+80	"	4.4	4.2	3.6	3.4	54449	
3+00	"	4.5	4.6	3.6	4.0	54412	
1+00	1+00					54490.6	11:48, Base station
0+80	1+20	3.0	2.8	2.8	2.8	54508	
1+00	"	3.0	3.0	3.0	3.1	54512	
+20	"	3.0	3.0	3.0	3.0	54517	
+40	"	3.0	2.9	3.4	3.1	54531	
+60	"	3.2	3.0	3.4	3.1	54523	
+80	"	3.2	3.1	3.2	3.0	54517	
2+00	"	3.5	3.0	3.4	3.2	54512	Stressed Veg (?)
+20	"	3.8	3.4	3.4	3.3	54506	
+40	"	3.8	3.5	3.4	3.0	54510	
+60	"	3.8	3.3	3.3	3.2	54507	
+80	"	4.0	4.0	3.1	3.3	54497	
3+00	"	5.84	4.8	3.8	3.8	54521	
1+00	1+00					54493.0	12:18, Base station
0+80	1+40	2.6	2.3	2.6	2.2	54516	
1+00	"	2.8	2.6	2.8	2.6	54525	
+20	"	3.0	2.6	3.0	3.0	54537	

P13 STUDY AREA - EM AND MAGNETOMETER DATA, SHEET 2 of 3

UC6Ø61   P13 DATA (Con't)   8-11-93   UC6Ø61   8-11-93

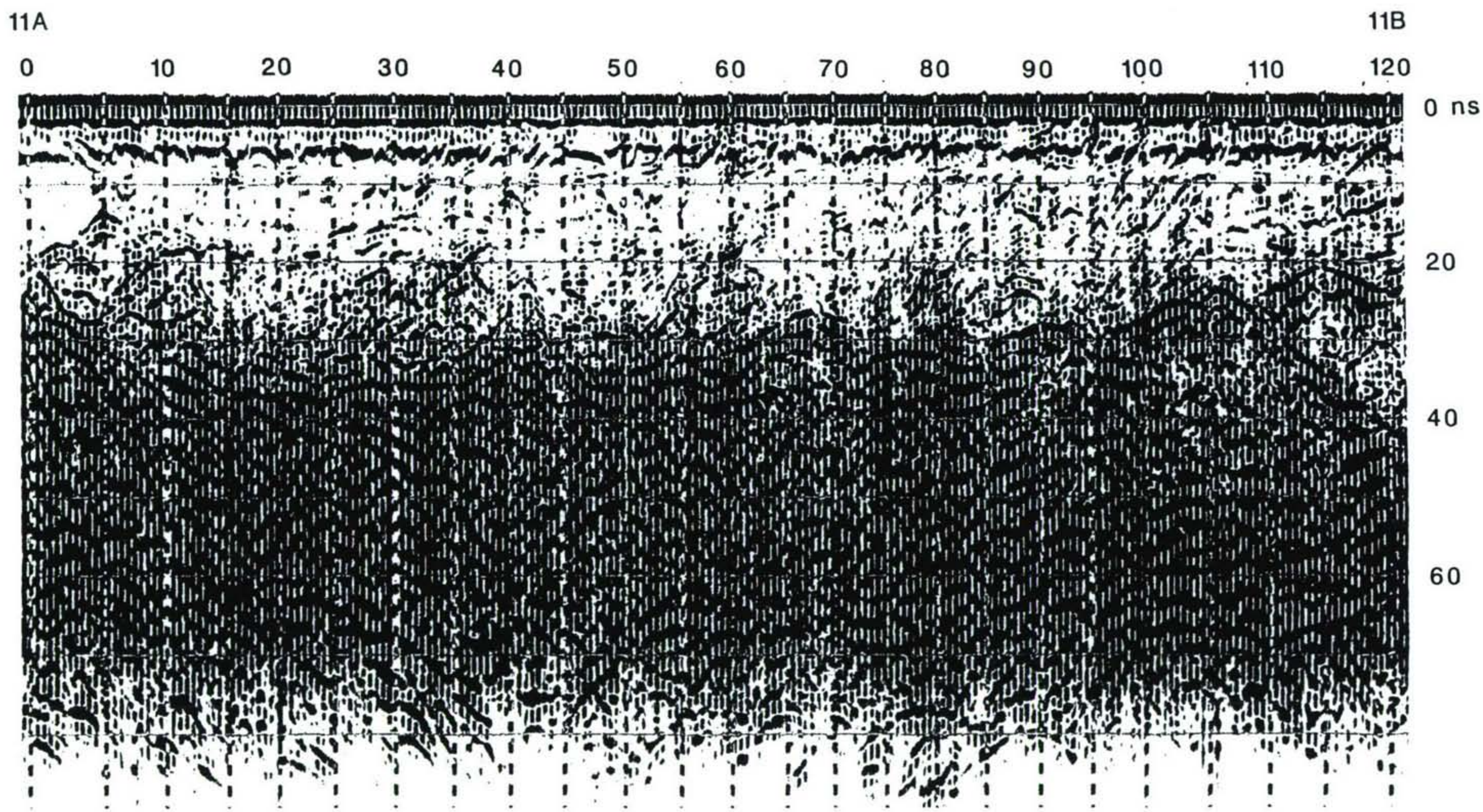
Station N	Station E.	V-Dipole N-S	V-Dipole E-W	H-Dipole N-S	H-Dipole E-W	Magnetometer Reading	Comments
1+60	1+80	5.4	5.1	5.4	5.4	54561	
+80	"	5.4	5.4	5.4	5.4	54567	
2+00	"	5.7	5.6	5.6	5.4	54568	
+20	"	5.8	5.5	5.6	5.4	54562	
+40	"	5.6	5.4	5.4	5.4	54561	
+60	"	5.4	5.0	5.6	5.6	54565	MH(?) has LØ readings
+80	"	6.4	7.0	5.8	5.6	54532	
3+00	"	6.0	6.1	5.6	5.5	54499	
1+00	1+00	5.6	5.6	5.4	5.4	54527.0	14:50, Base station
1+00	2+00	5.3	5.3	5.3	5.4	54562	
+20	"	5.1	5.0	5.5	5.5	54569	
+40	"	5.0	5.1	5.5	5.8	54569	
+60	"	5.2	5.4	5.6	5.4	54571	
+80	"	5.1	5.0	5.4	5.5	54571	
2+00	"	5.3	5.3	5.5	5.6	54573	
+20	"	5.5	5.4	5.5	5.8	54573	
+40	"	5.0	5.4	6.2	6.0	54577	
+60	"	5.5	5.4	5.7	5.8	54565	
+80	"	5.8	5.6	5.9	5.8	54565	
3+00	"	6.1	6.0	6.2	5.9	54533	
1+00	1+00					54523.4	15:25, Base Station Top of slope
1+20	2+20	5.7	5.6	6.5	6.2	54569	
+40	"	5.6	5.5	6.2	5.8	54575	
+60	"	5.5	5.6	6.2	6.0	54574	
+80	"	5.9	5.6	6.0	6.2	54573	
2+00	"	5.8	5.5	6.1	5.9	54576	
+20	"	5.9	5.1	6.4	6.2	54583	
+40	"	6.0	5.9	6.0	6.1	54568	
+60	"	5.9	5.7	6.2	6.2	54573	
+80	"	6.2	6.0	6.0	6.1	54580	
3+00	"	6.3	6.0	6.2	6.3	54586	

P13 STUDY AREA – EM AND MAGNETOMETER DATA, SHEET 3 of 3

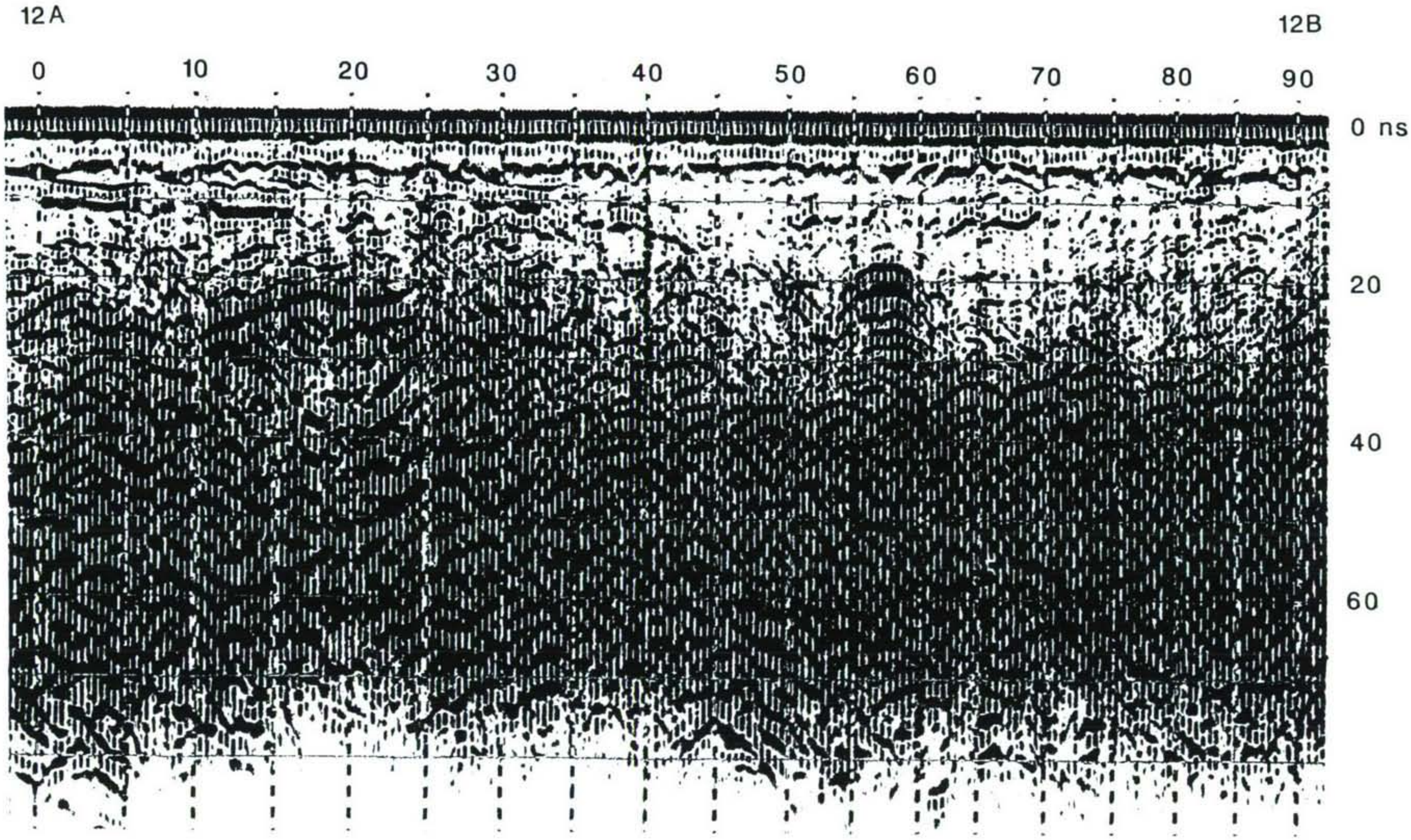
APPENDIX E

ATTACHMENT D

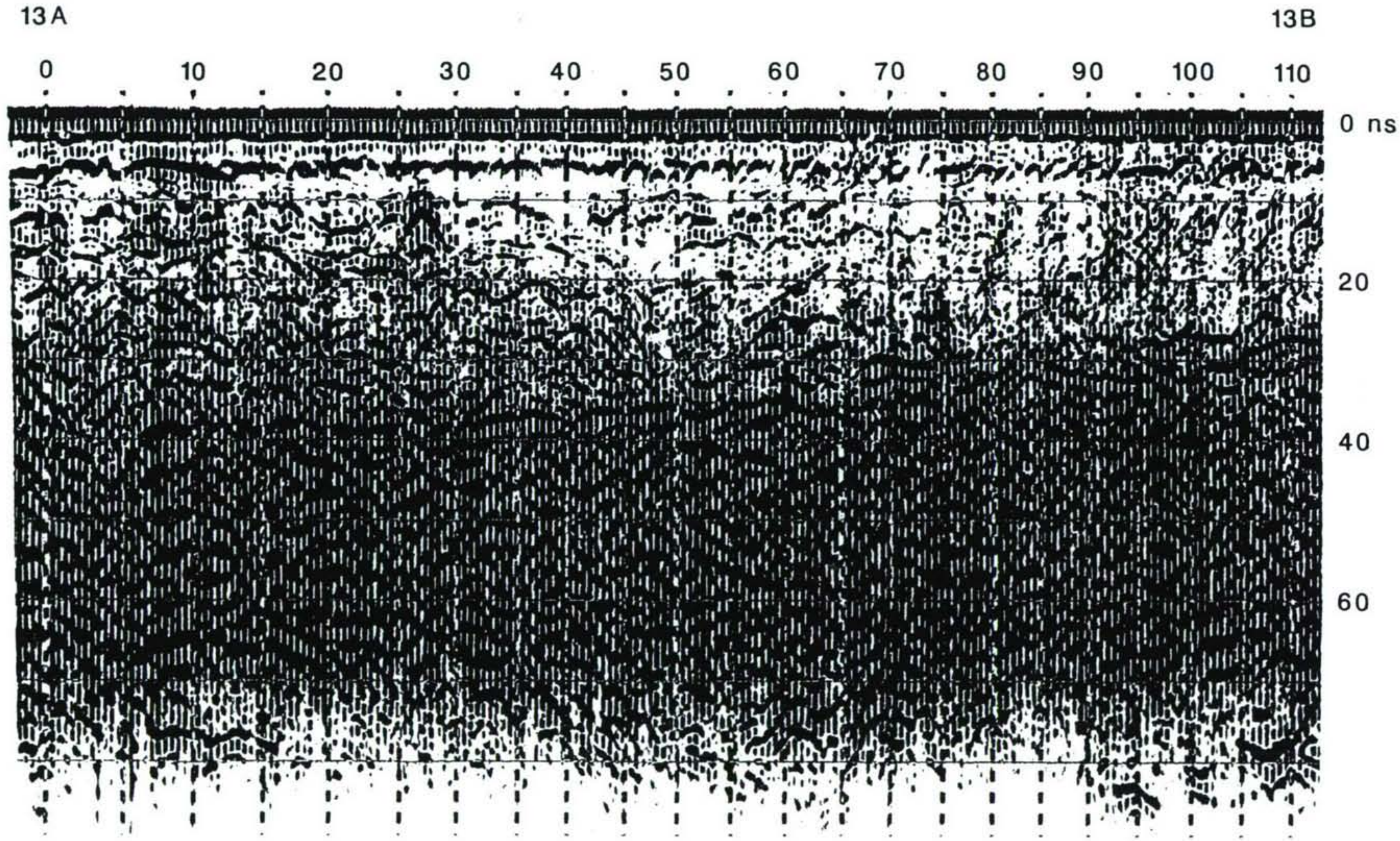
A11 STUDY AREA GPR PROFILES



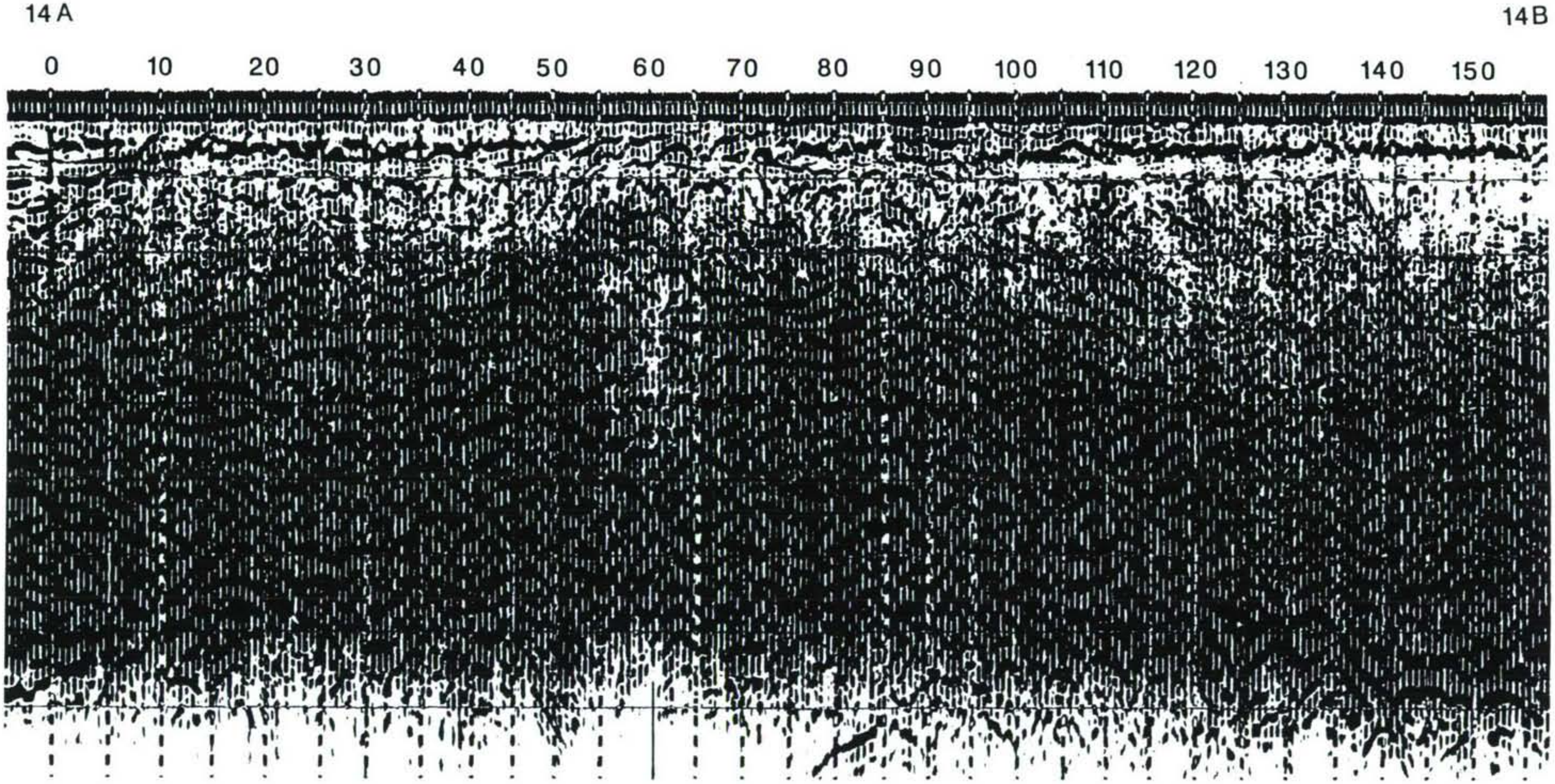
A11 STUDY AREA (South Portion) - LINE GPR-11 (500 MHz ANTENNA)



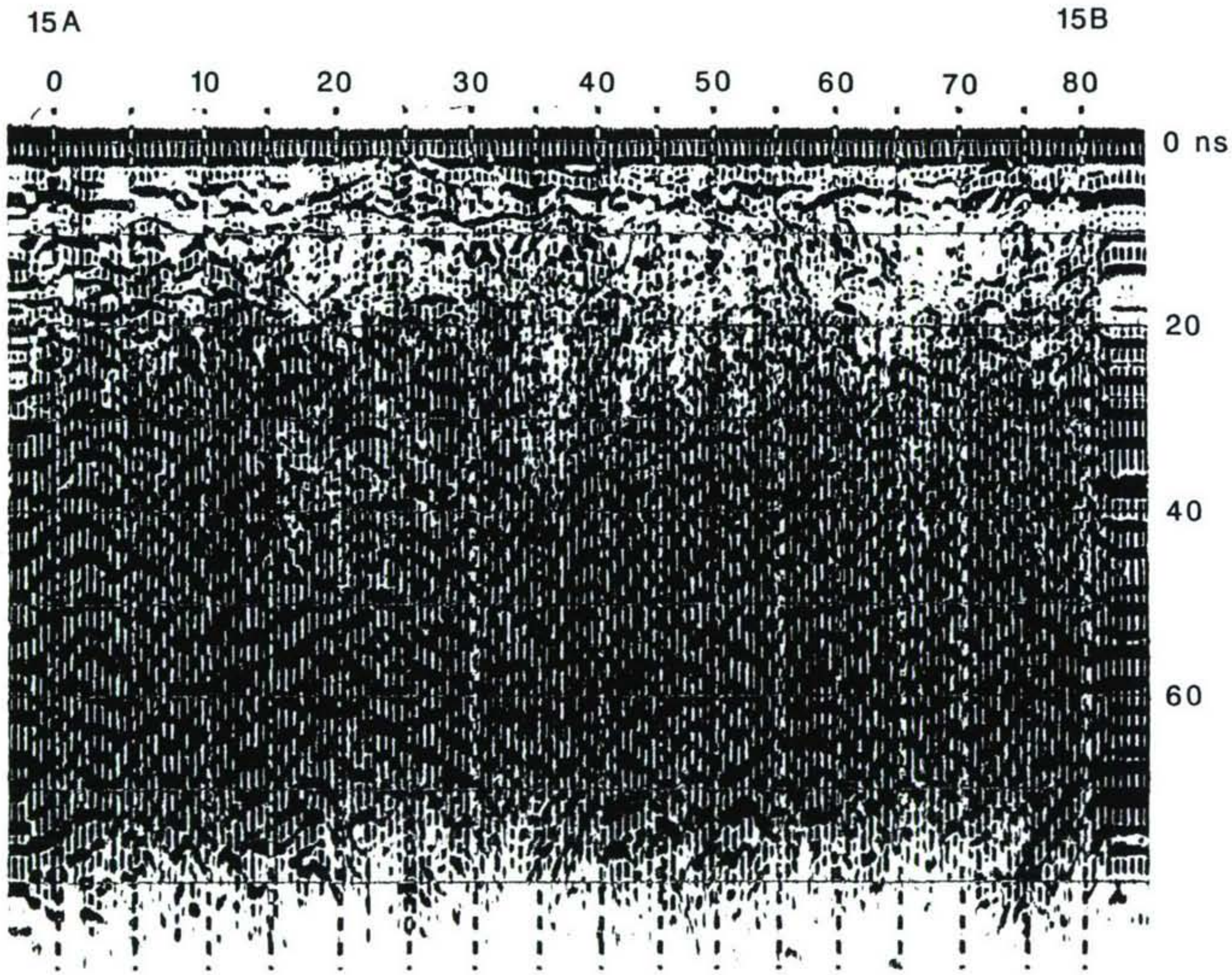
A11 STUDY AREA (South Portion) - LINE GPR-12 (500 MHz ANTENNA)



A11 STUDY AREA (South Portion) - LINE GPR-13 (500 MHz ANTENNA)

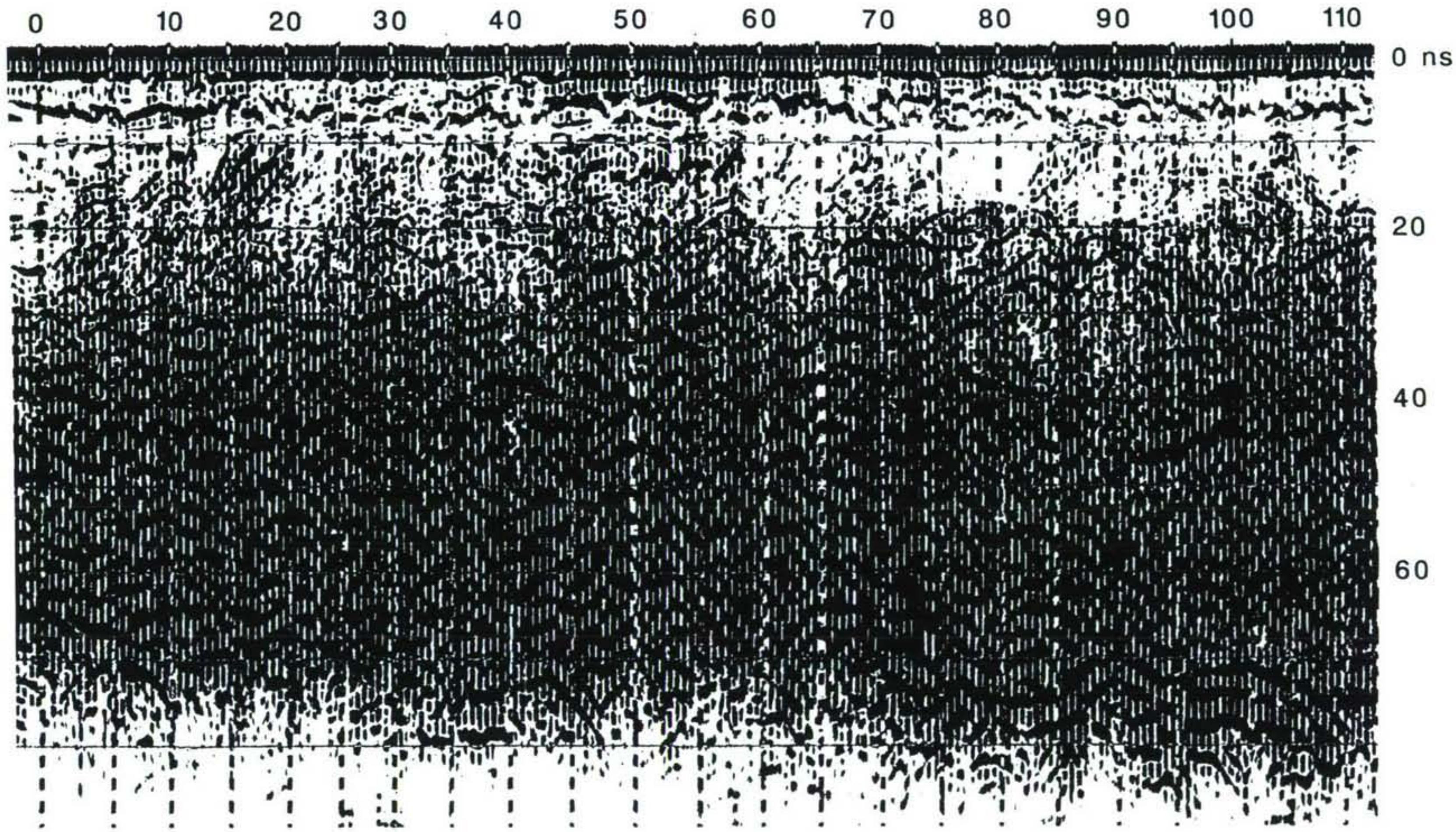


A11 STUDY AREA (South Portion) - LINE GPR-14 (500 MHz ANTENNA)

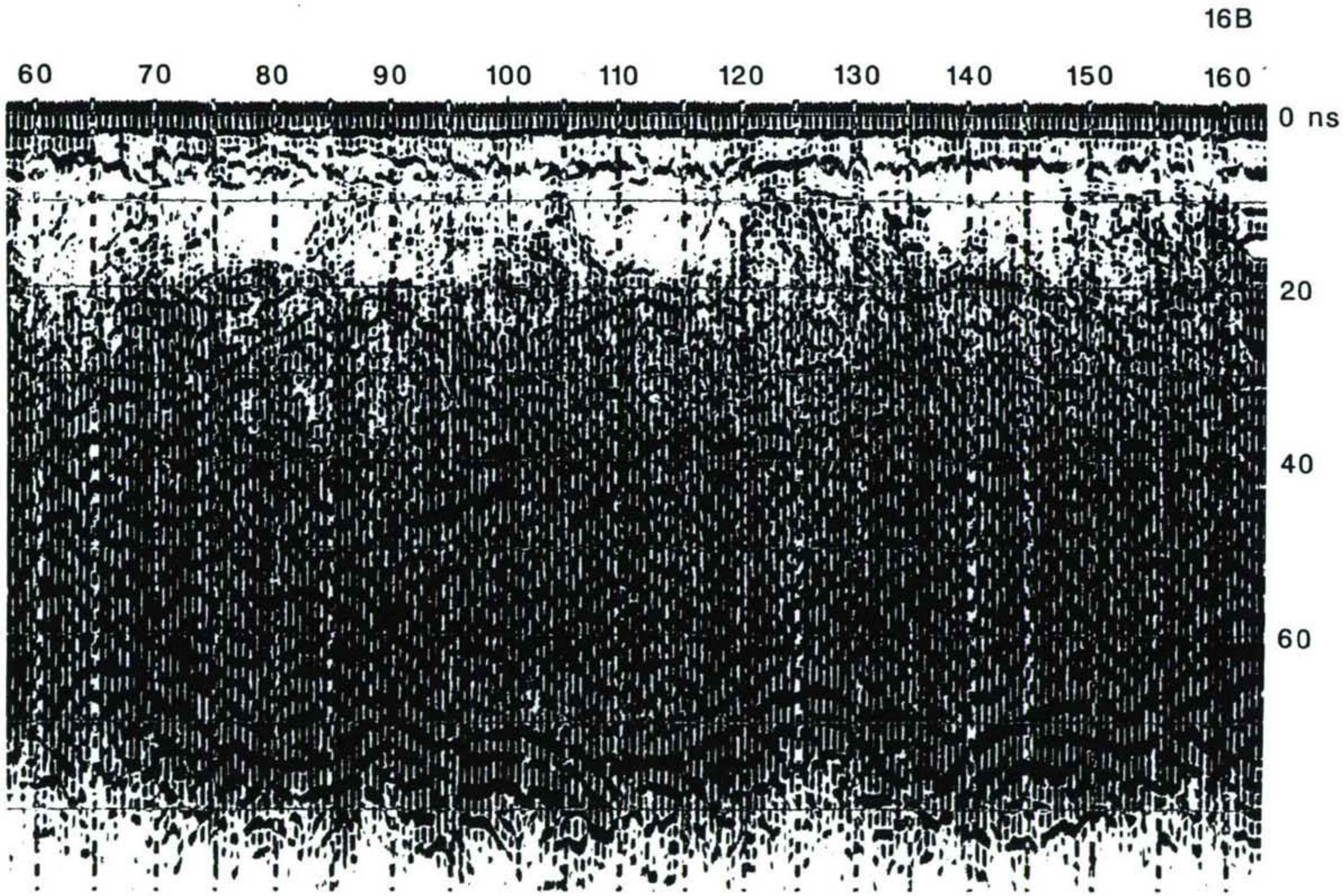


A11 STUDY AREA (South Portion) - LINE GPR-15 (500 MHz ANTENNA)

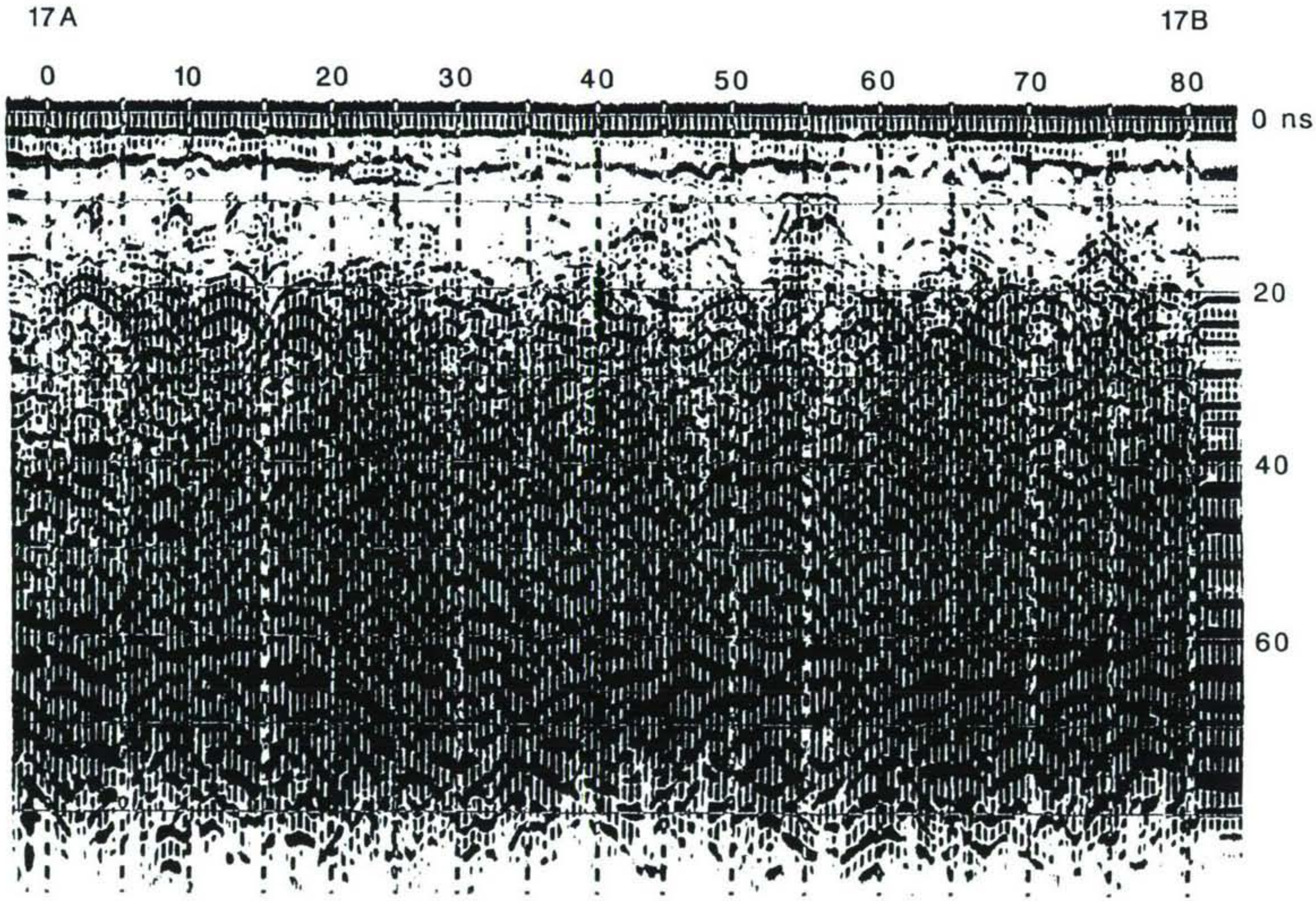
16A



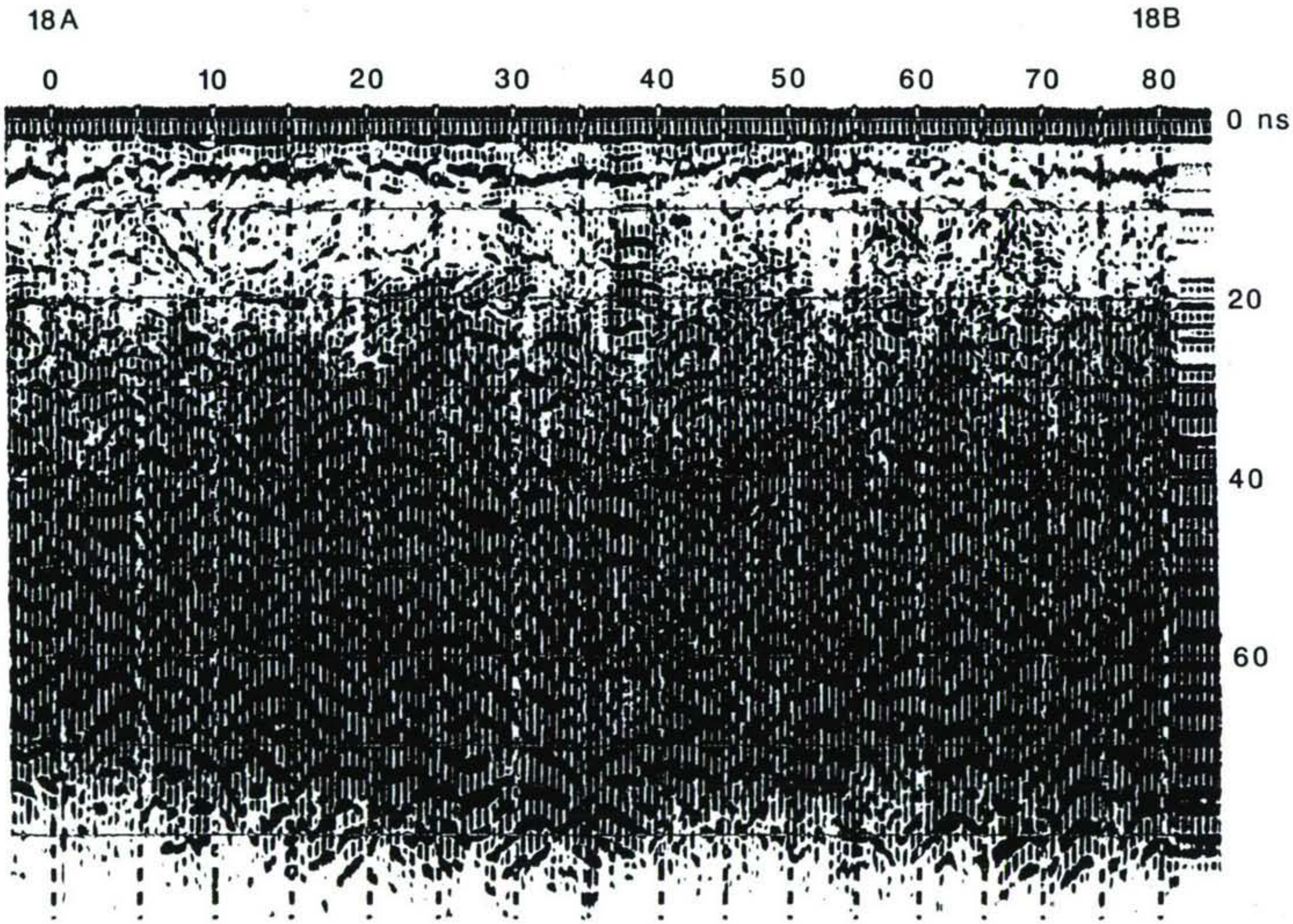
A11 STUDY AREA (South Portion) - PARTIAL LINE GPR-16 (500 MHz ANTENNA)



A11 STUDY AREA (South Portion) - PARTIAL LINE GPR-16 (500 MHz ANTENNA)



A11 STUDY AREA (South Portion) - LINE GPR-17 (500 MHz ANTENNA)



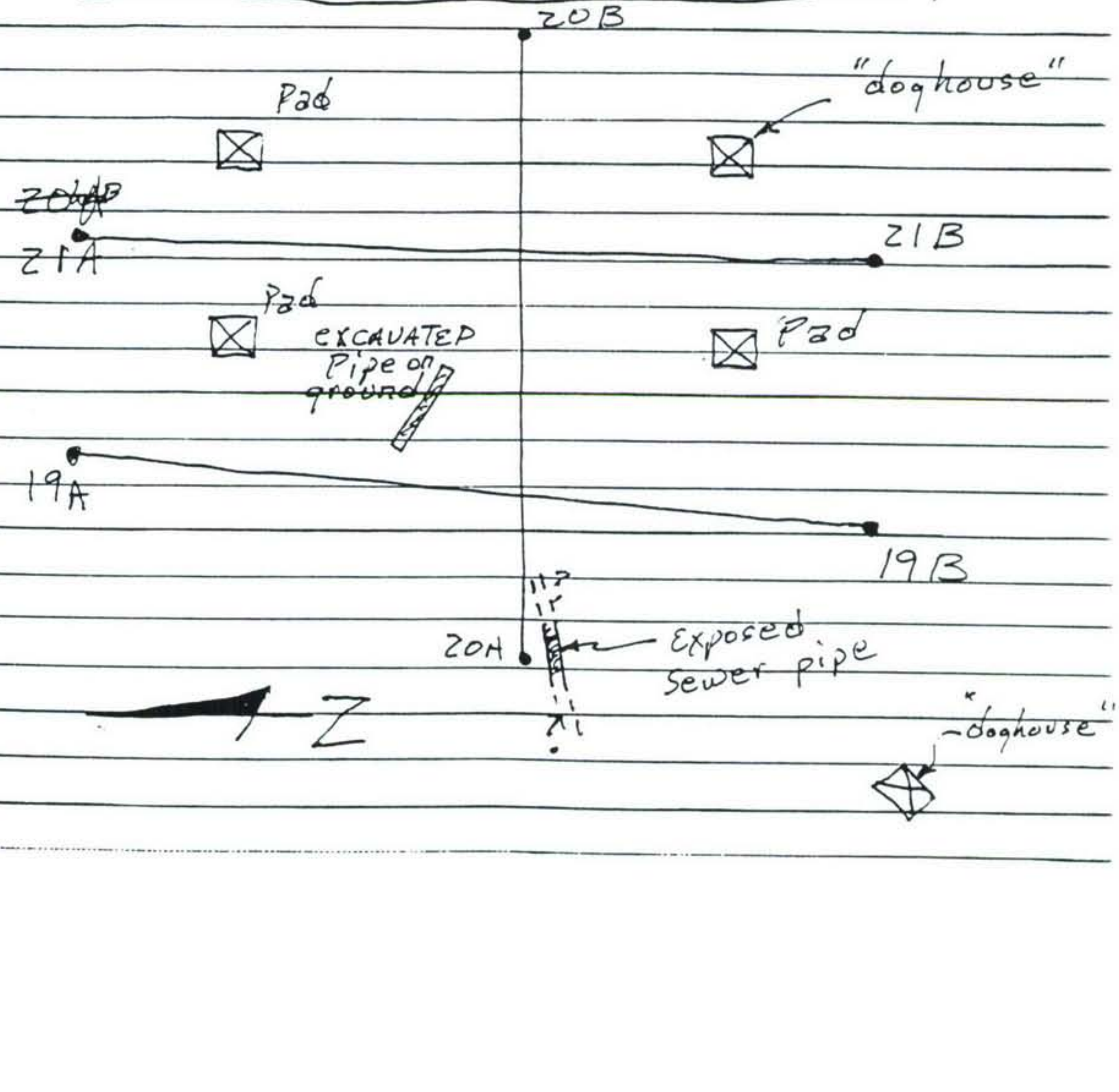
A11 STUDY AREA (South Portion) - LINE GPR-18 (500 MHz ANTENNA)

1415 - Run GPR-19 (at A11 North).
19A @ Ø, 19B @ 60'.

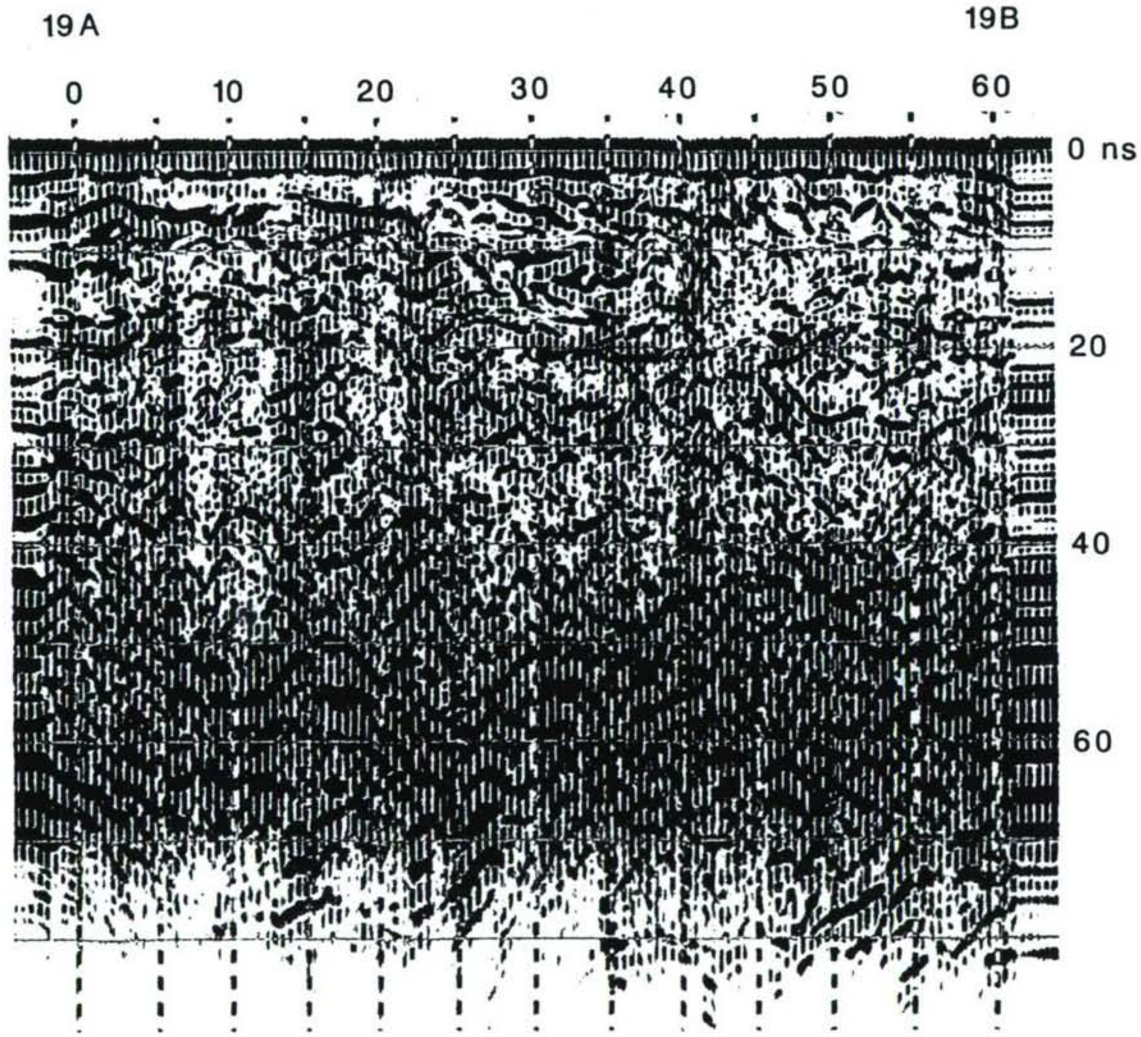
1425 - Run GPR-20.
20A @ Ø, 20B @ 120'.

1440 - Run GPR-21.
21A @ Ø, 21B @ 75'.

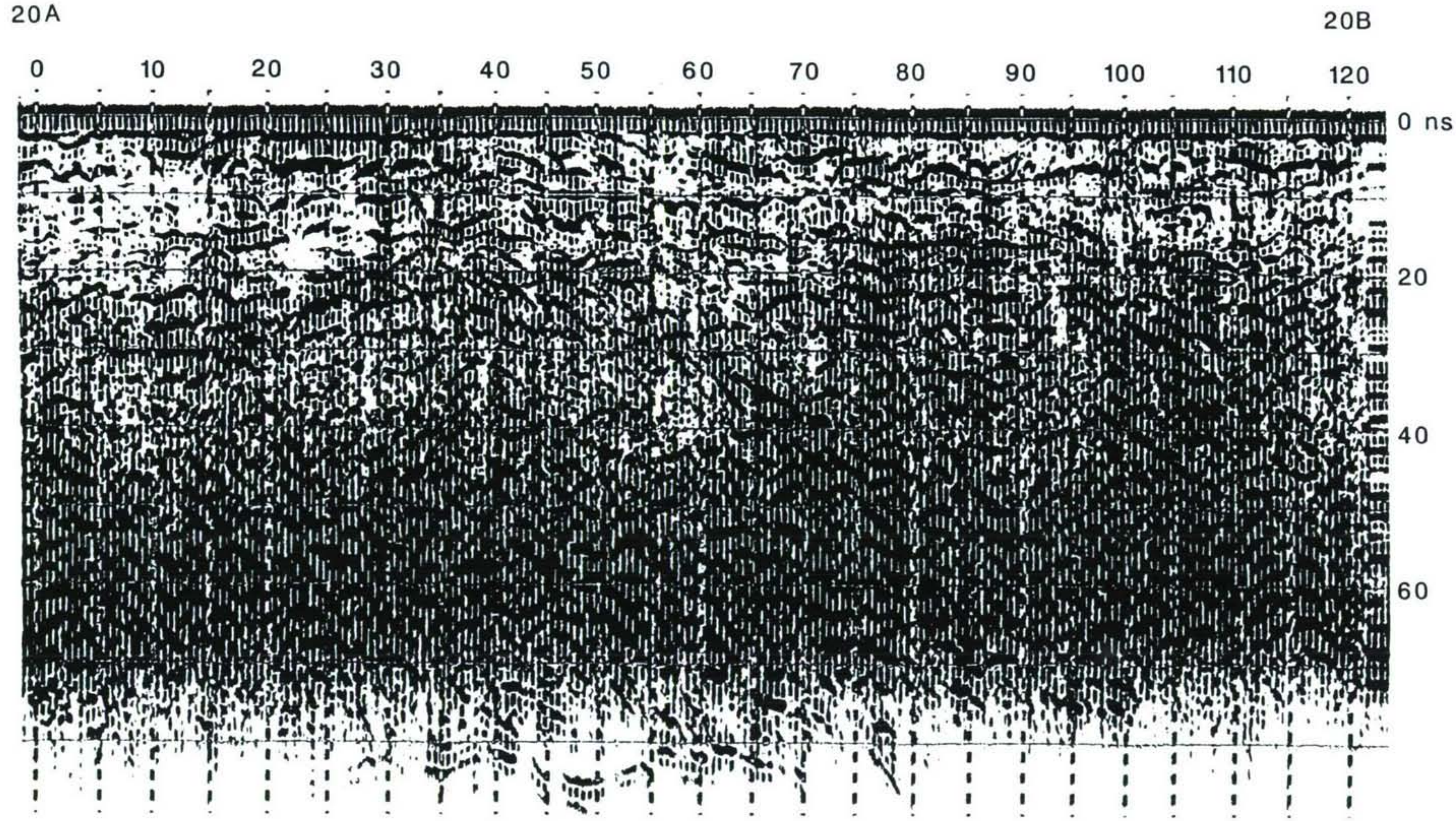
A11 (North) Sketch Map



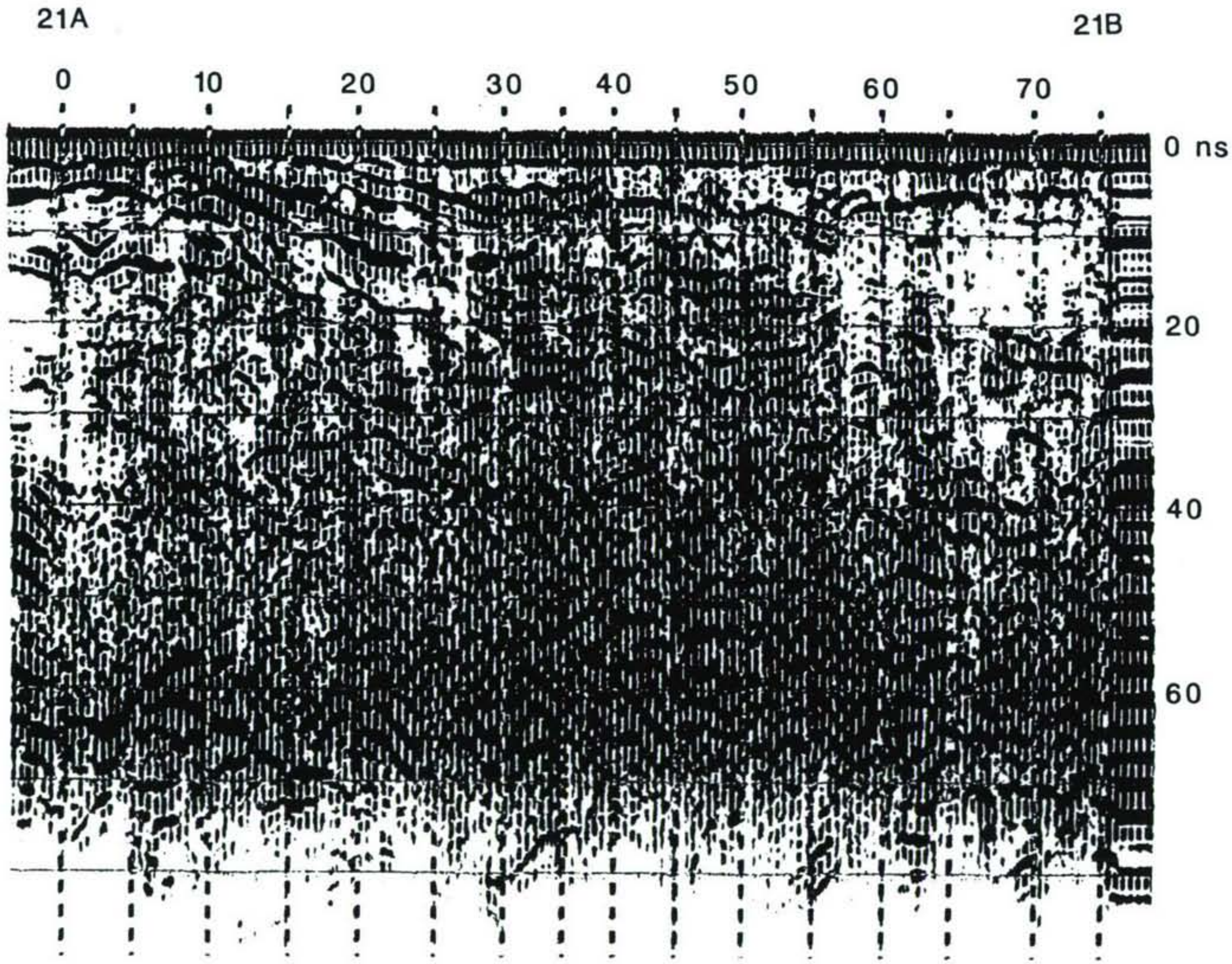
A11 STUDY AREA (North Portion) GPR LOCATION MAP



A11 STUDY AREA (North Portion) - LINE GPR-19 (500 MHz ANTENNA)



A11 STUDY AREA (North Portion) - LINE GPR-20 (500 MHz ANTENNA)



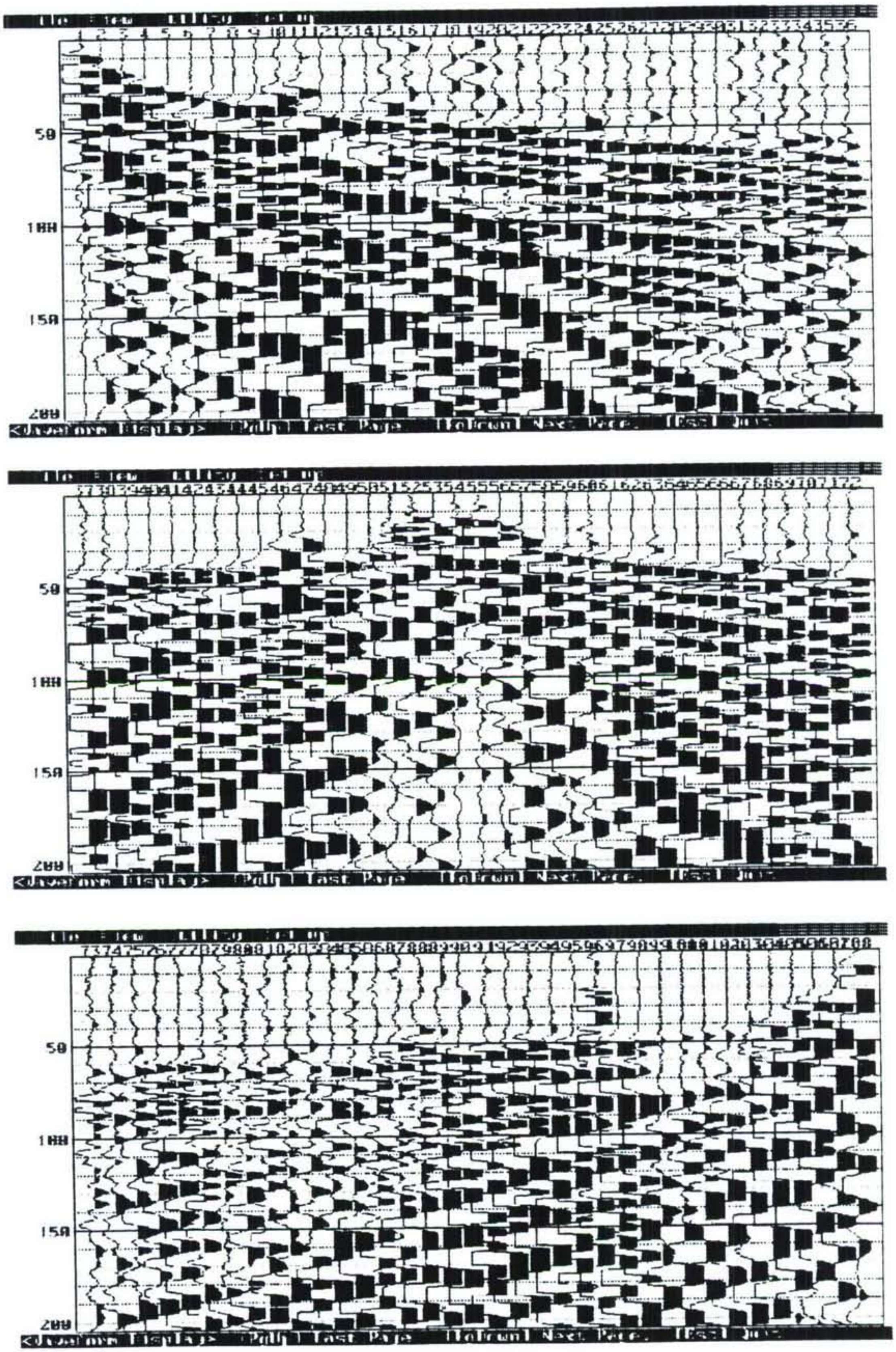
A11 STUDY AREA (North Portion) - LINE GPR-21 (500 MHz ANTENNA)

APPENDIX E

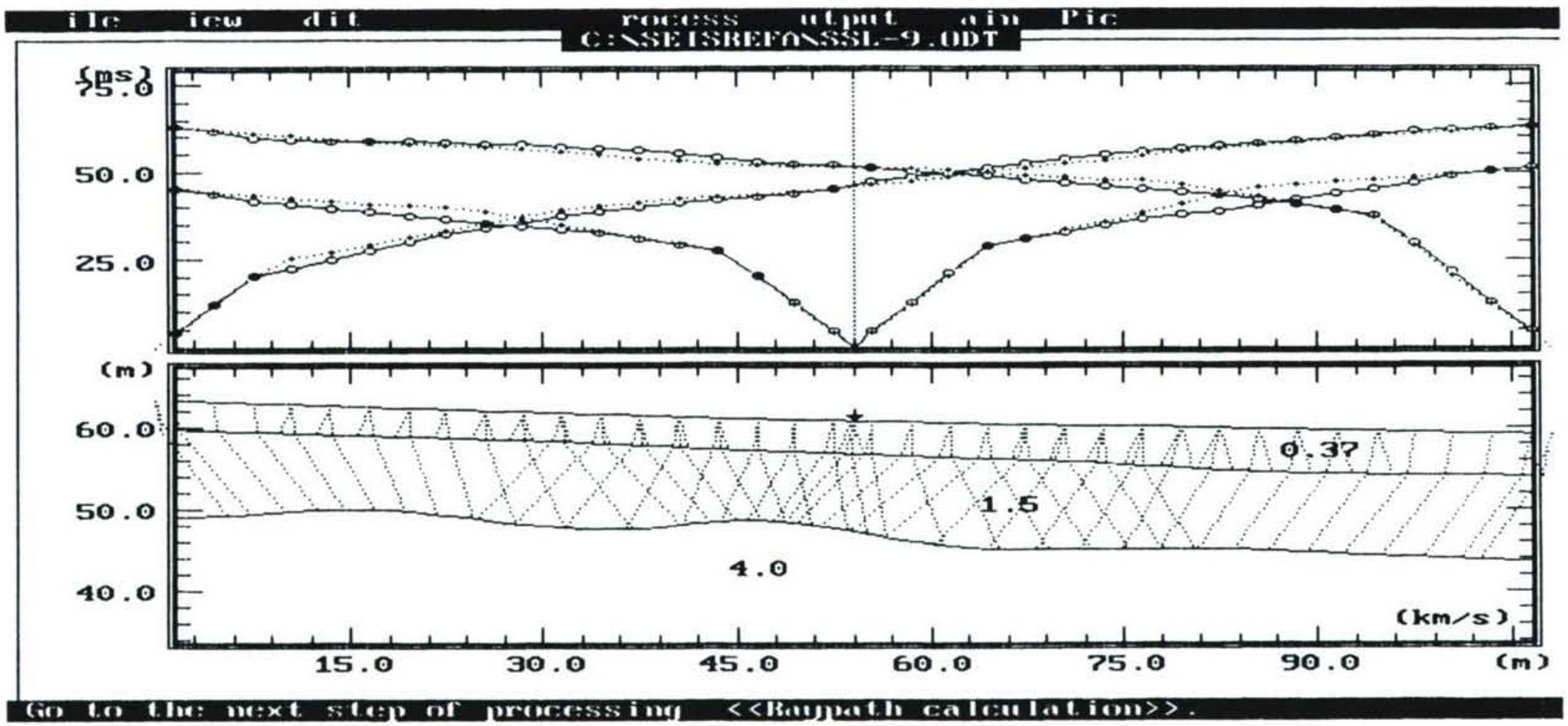
ATTACHMENT E

P36/P37 STUDY AREAS
SEISMIC DATA

SSL-9

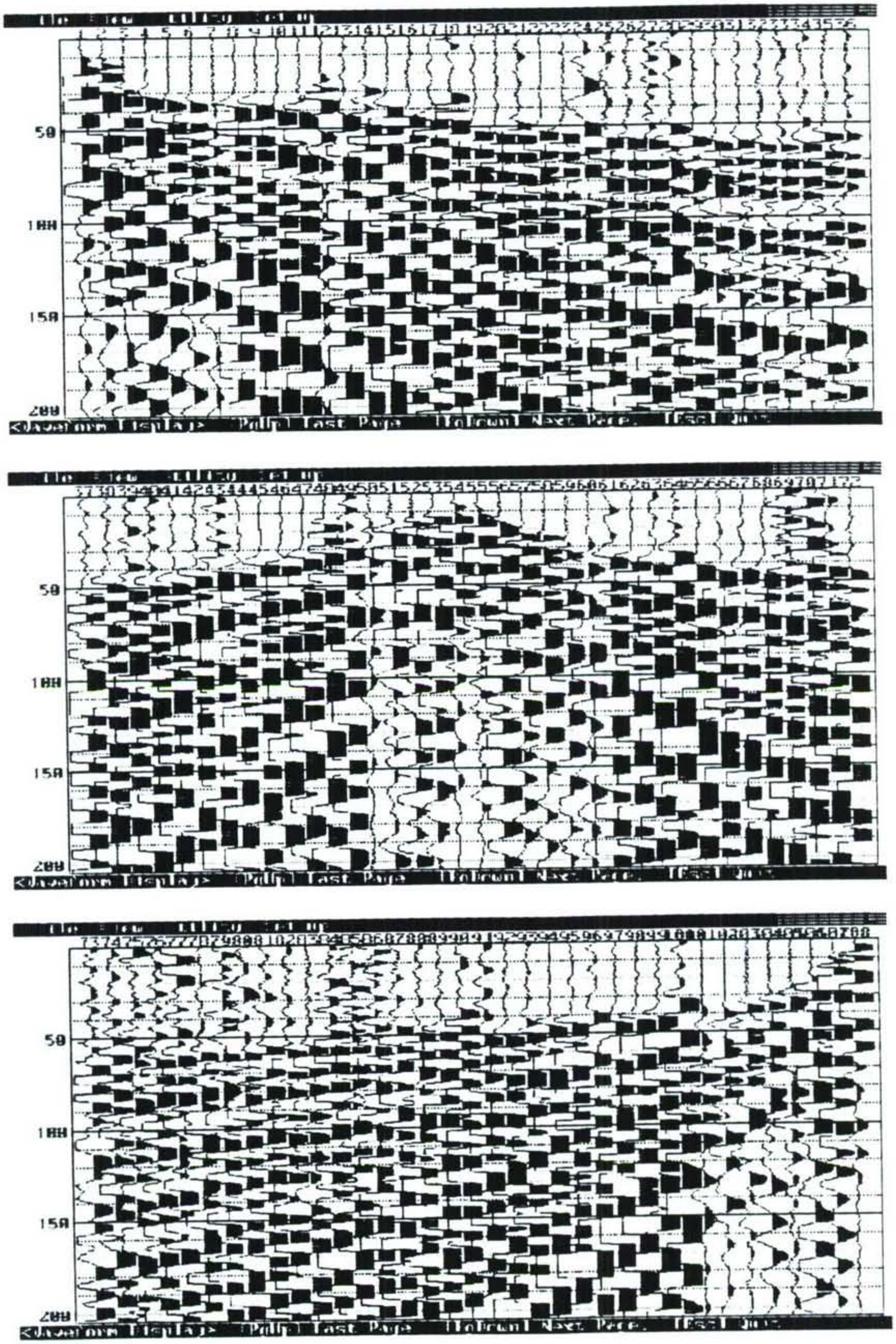


P36/P37 STUDY AREA - SEISMIC LINE SSL-9

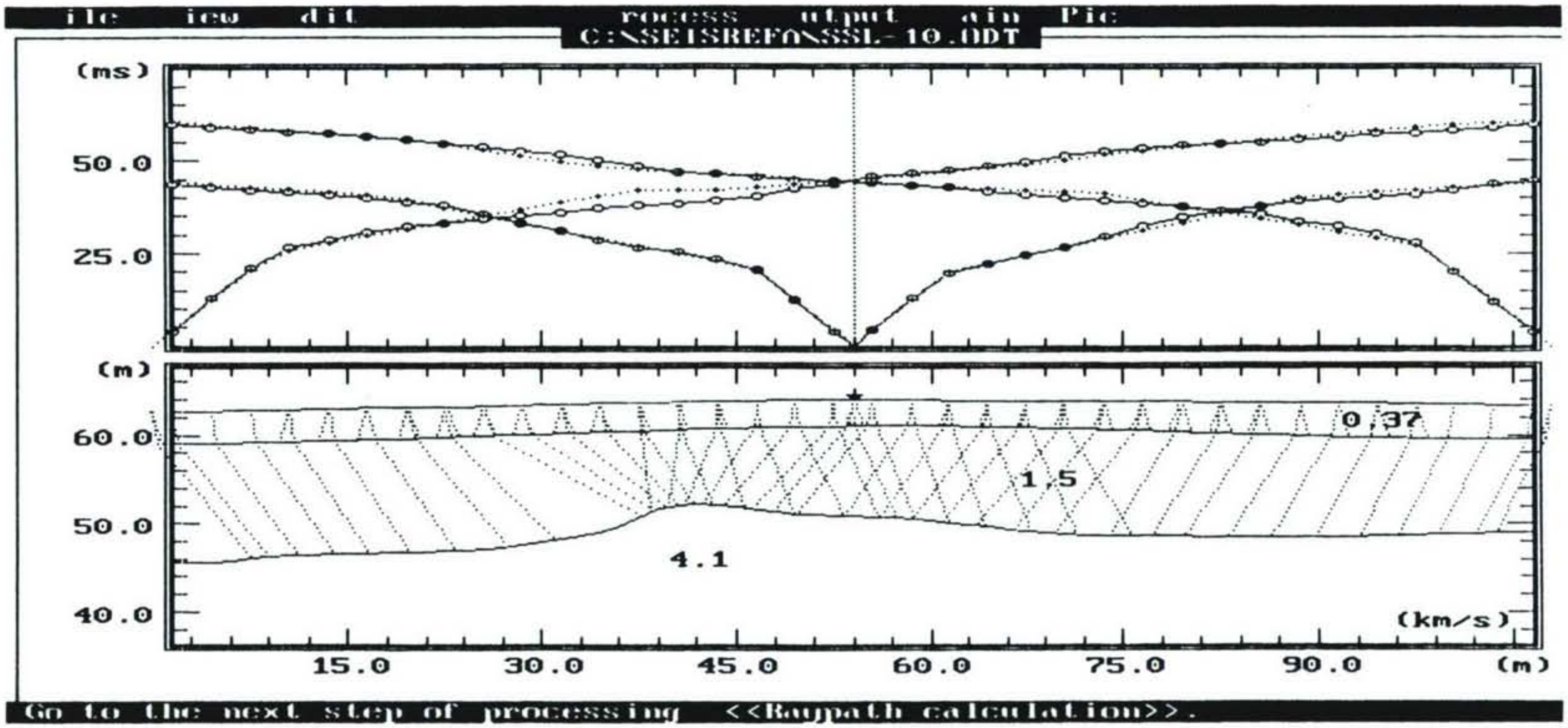


P36/P37 STUDY AREA - SEISMIC LINE SSL-9

SSL-10

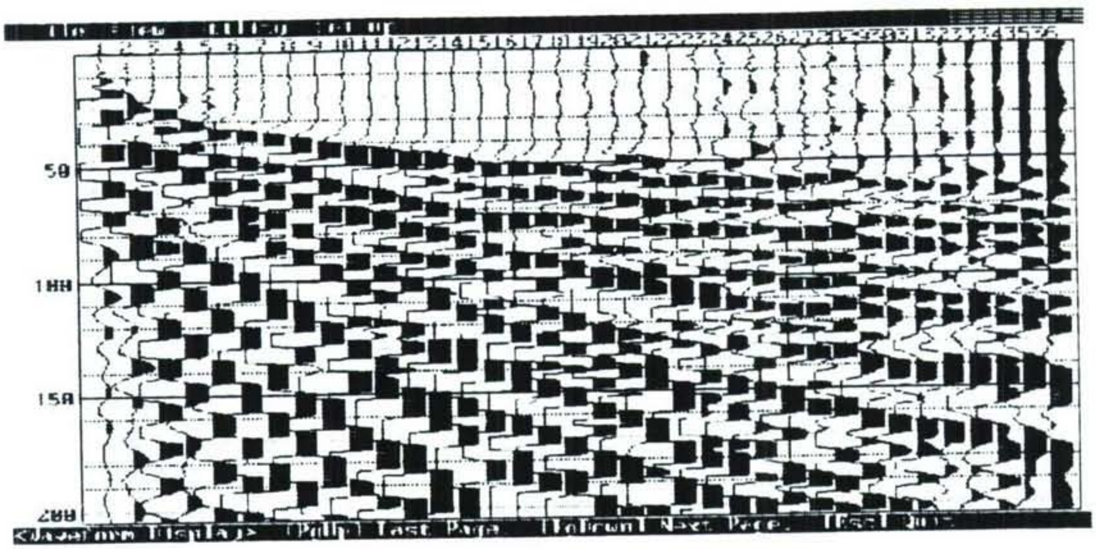


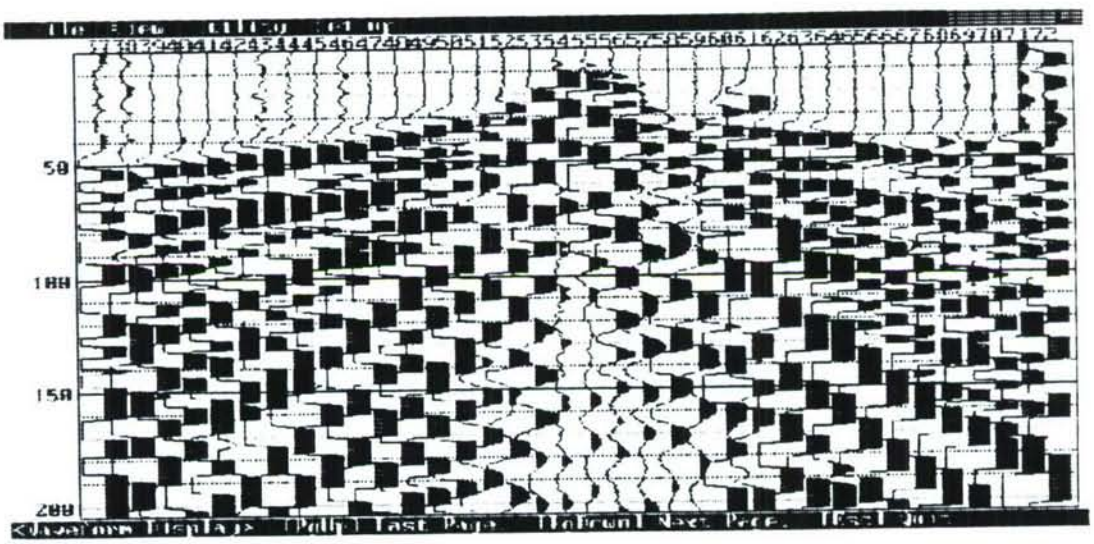
P36/P37 STUDY AREA – SEISMIC LINE SSL-10

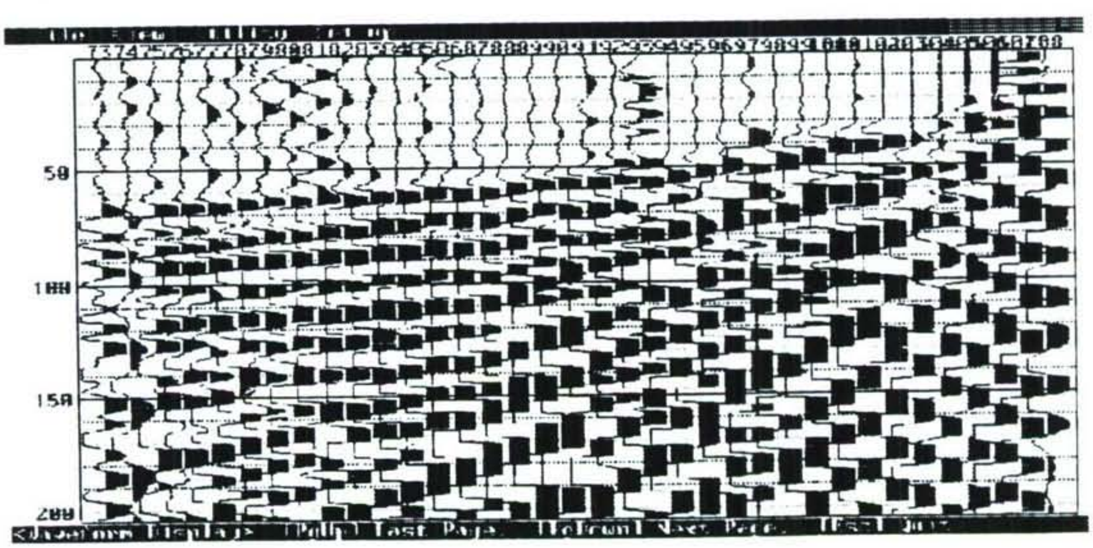


P36/P37 STUDY AREA - SEISMIC LINE SSL-10

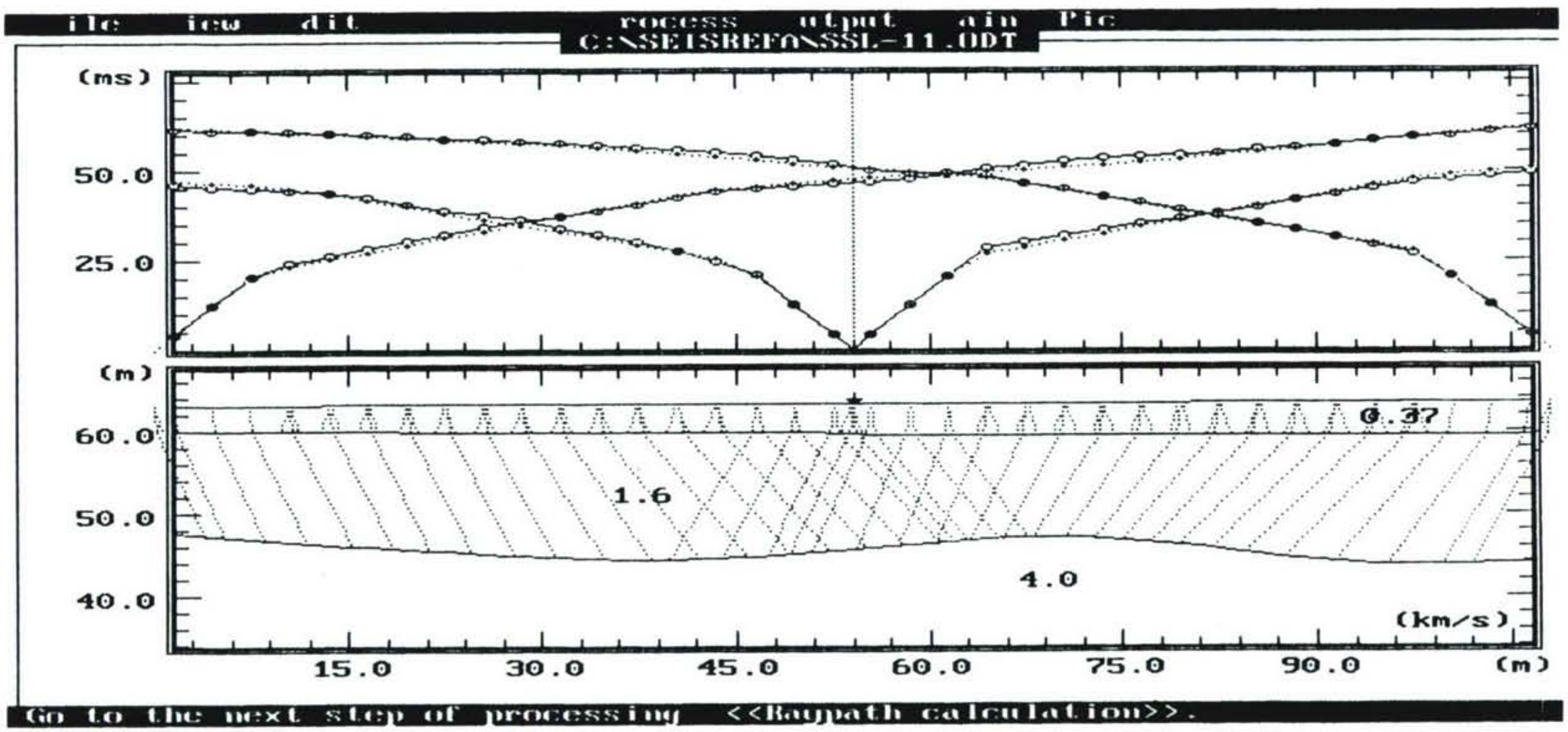
SSL-11





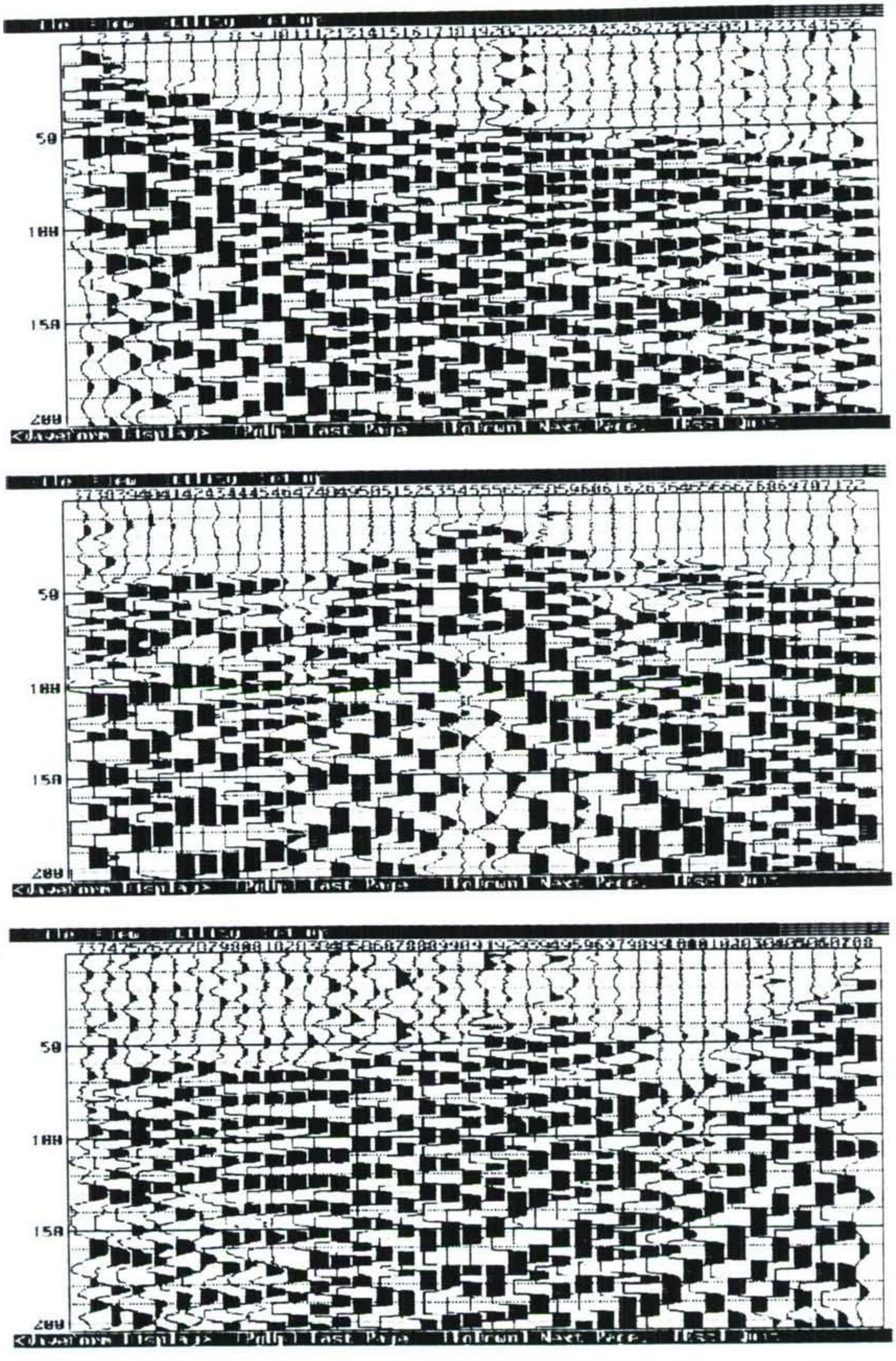


P36/P37 STUDY AREA - SEISMIC LINE SSL-11

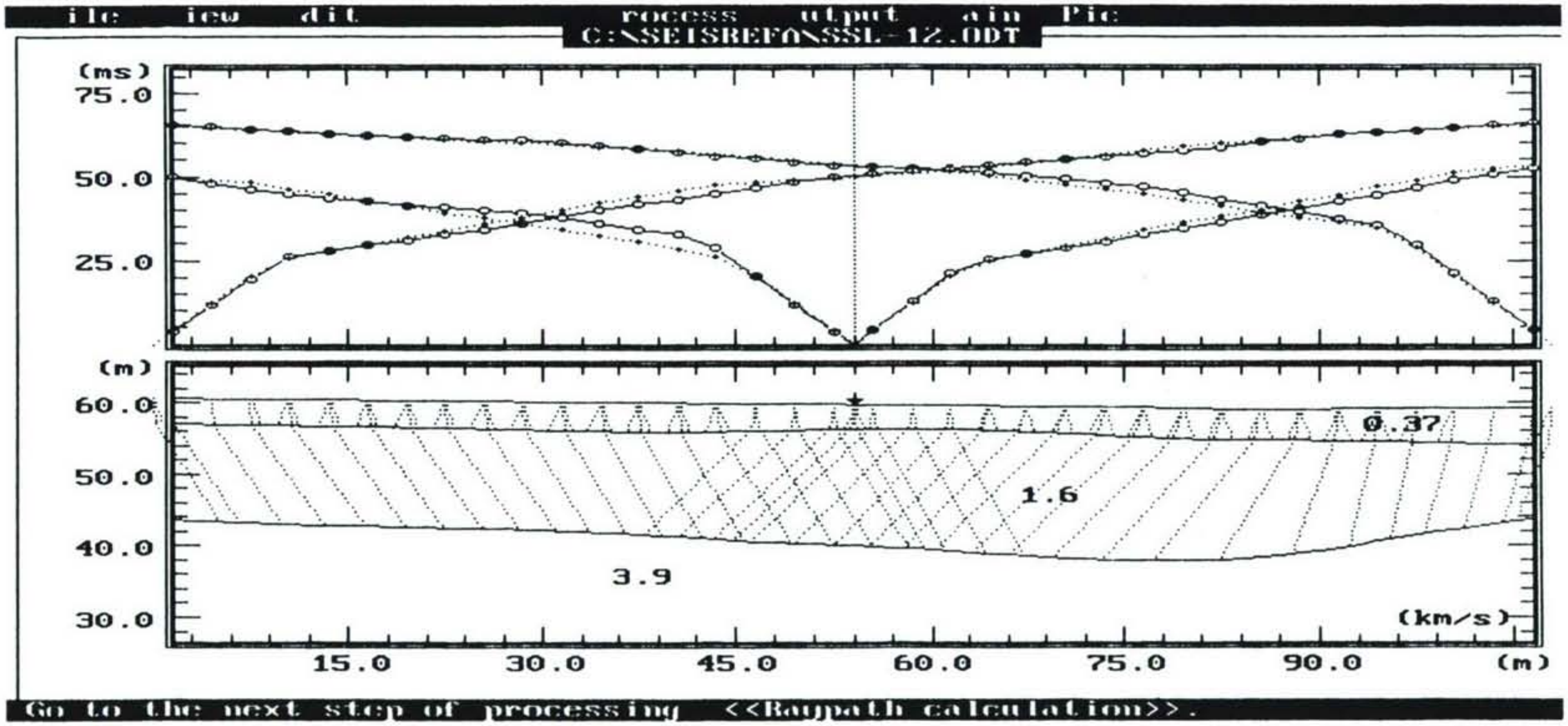


P36/P37 STUDY AREA - SEISMIC LINE SSL-11

SSL-12

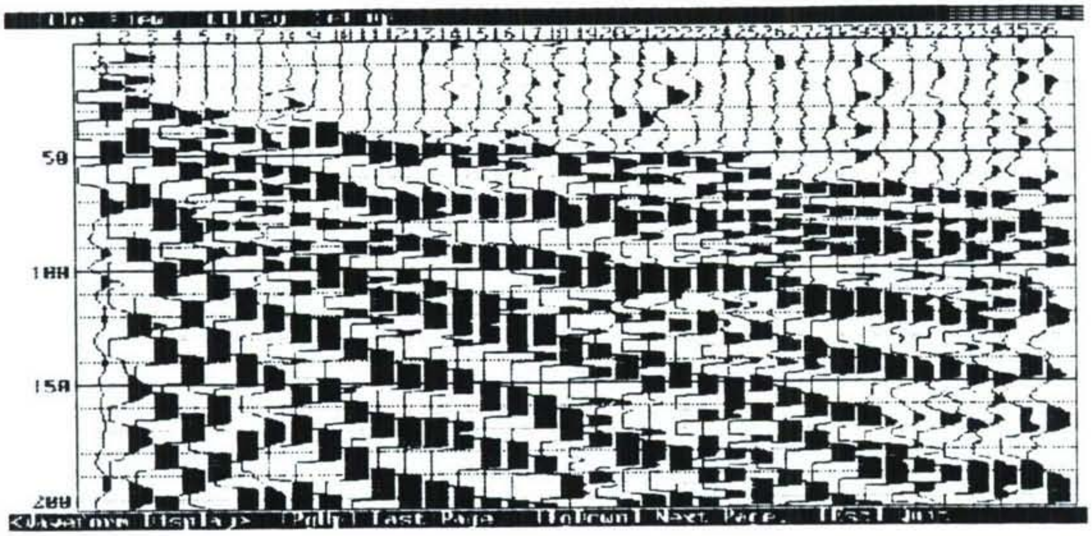


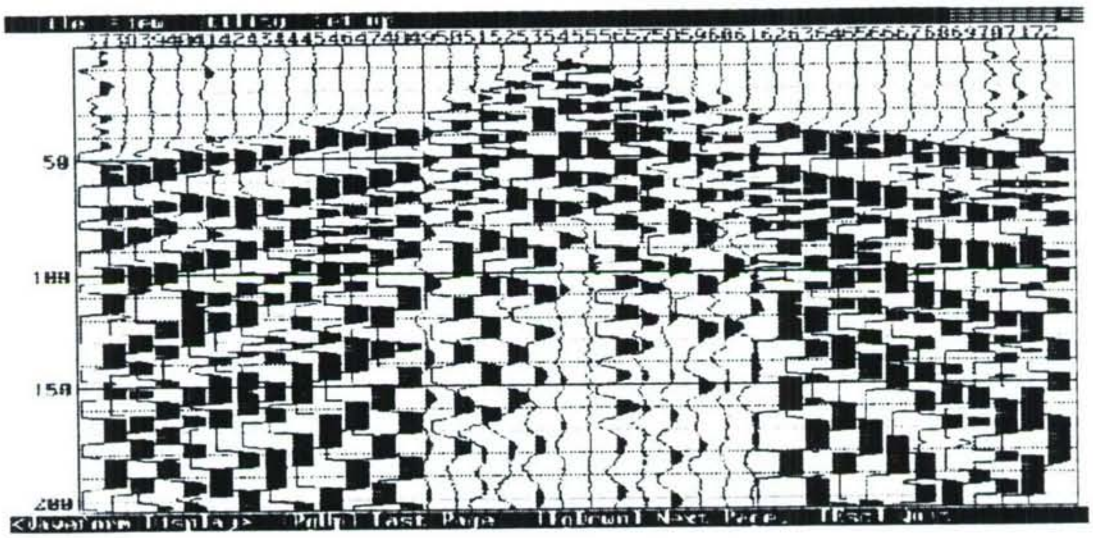
P36/P37 STUDY AREA – SEISMIC LINE SSL-12

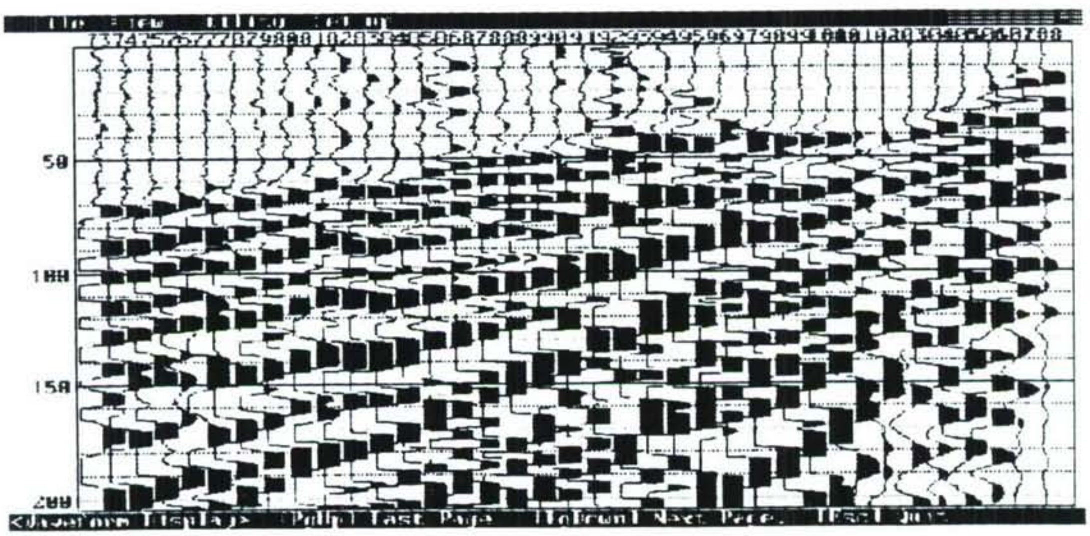


P36/P37 STUDY AREA - SEISMIC LINE SSL-12

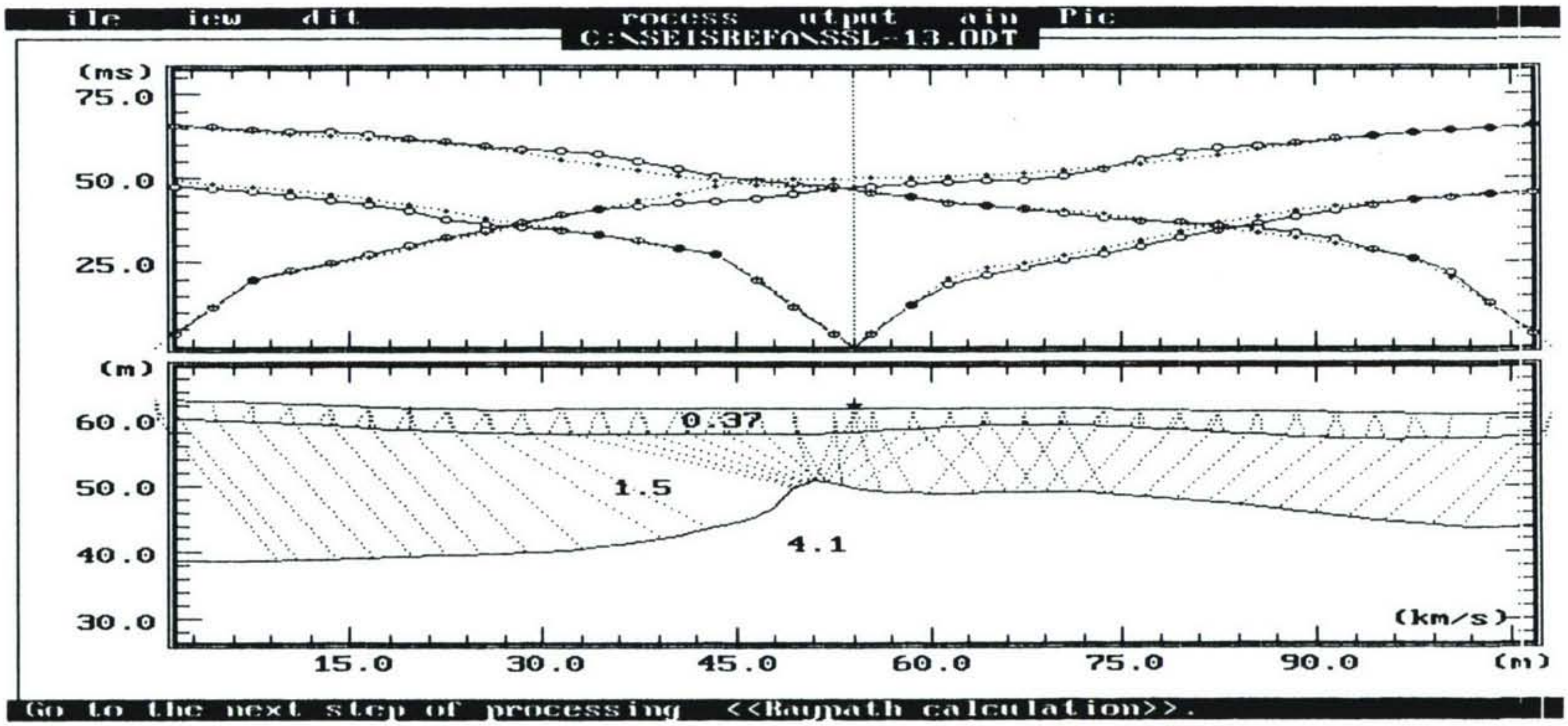
SSL-13





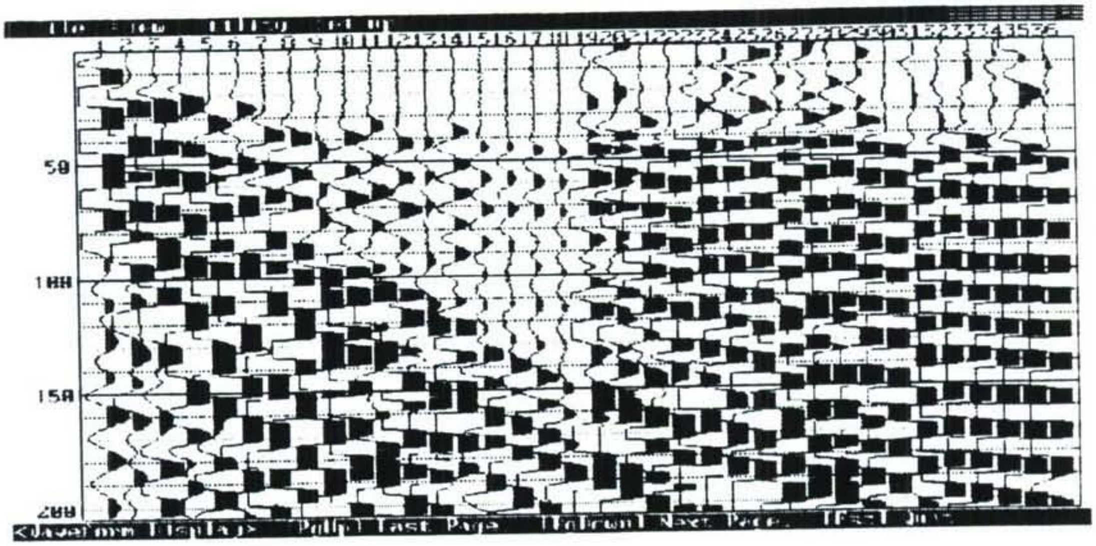


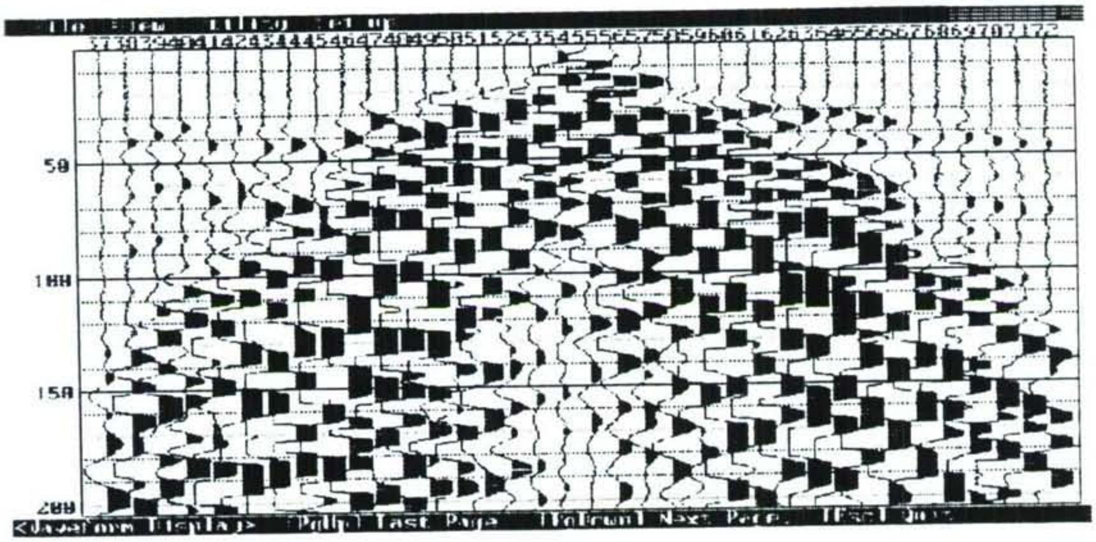
P36/P37 STUDY AREA - SEISMIC LINE SSL-13

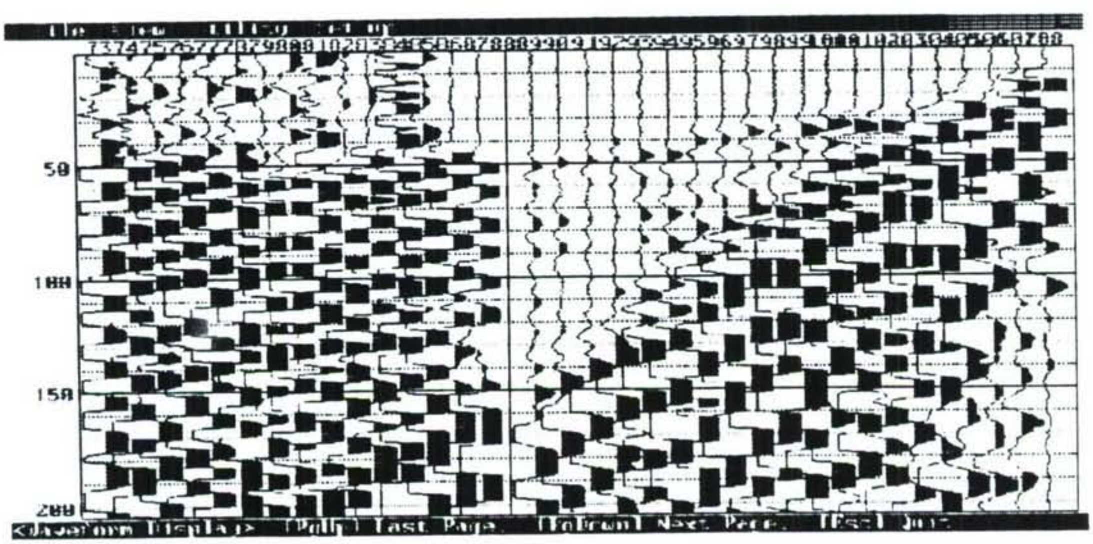


P36/P37 STUDY AREA - SEISMIC LINE SSL-13

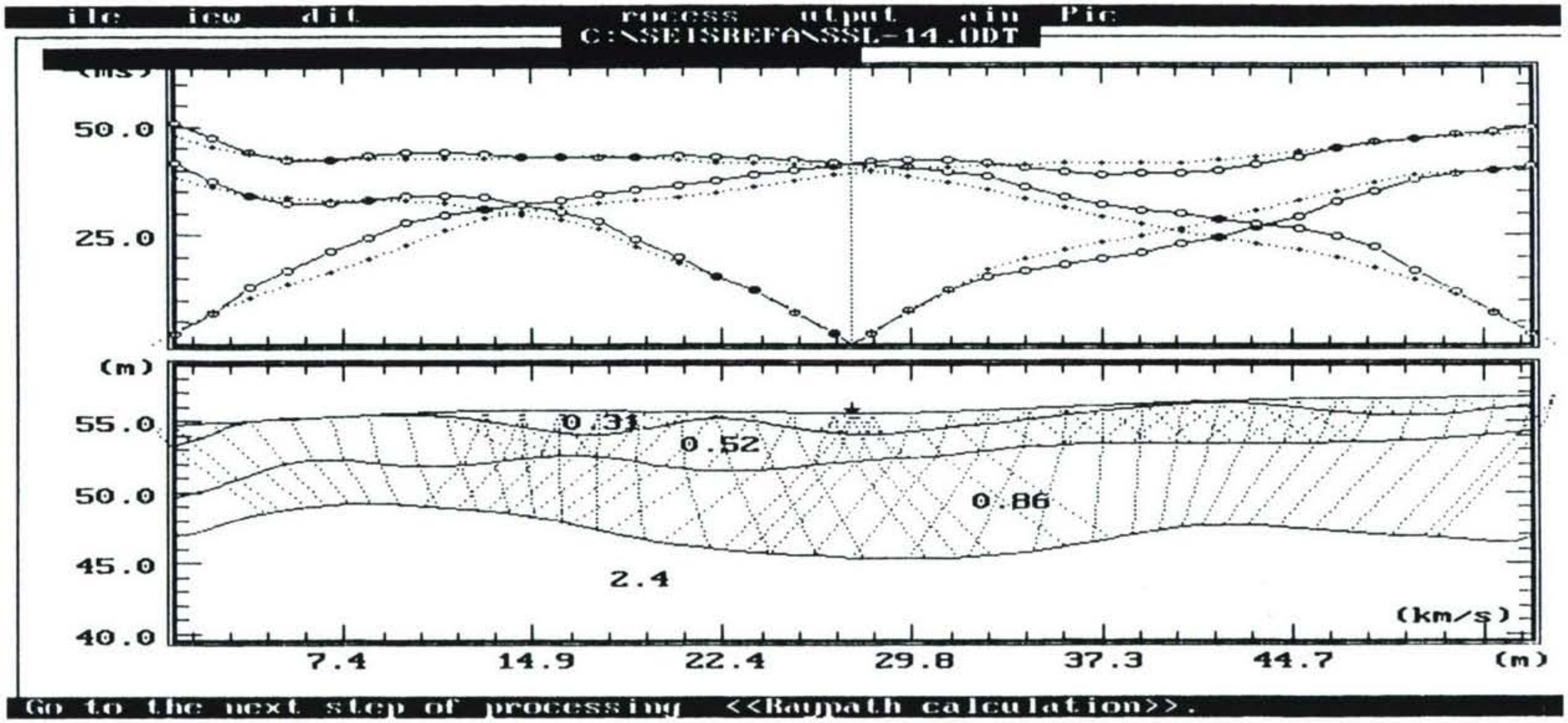
SSL-14





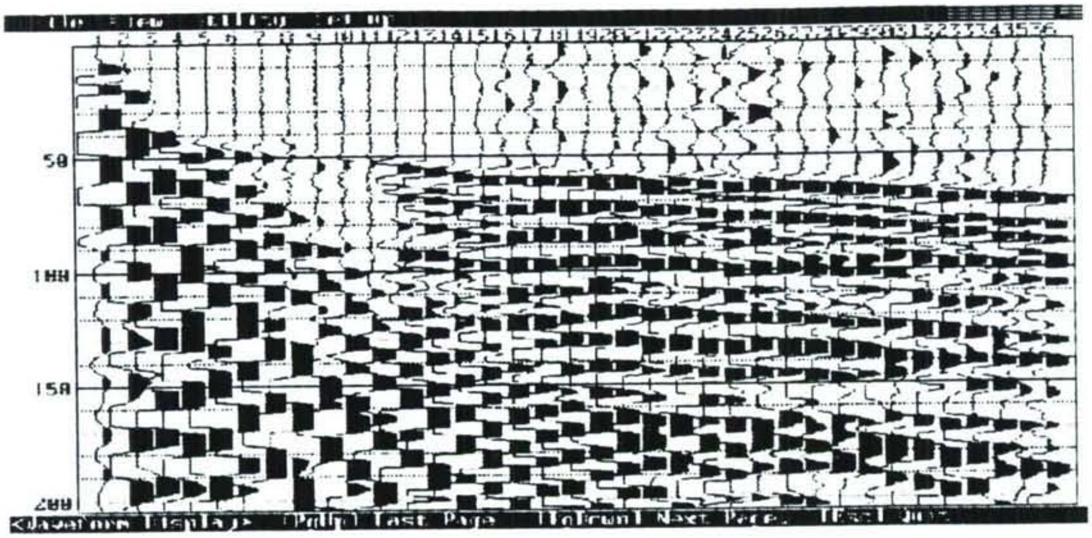


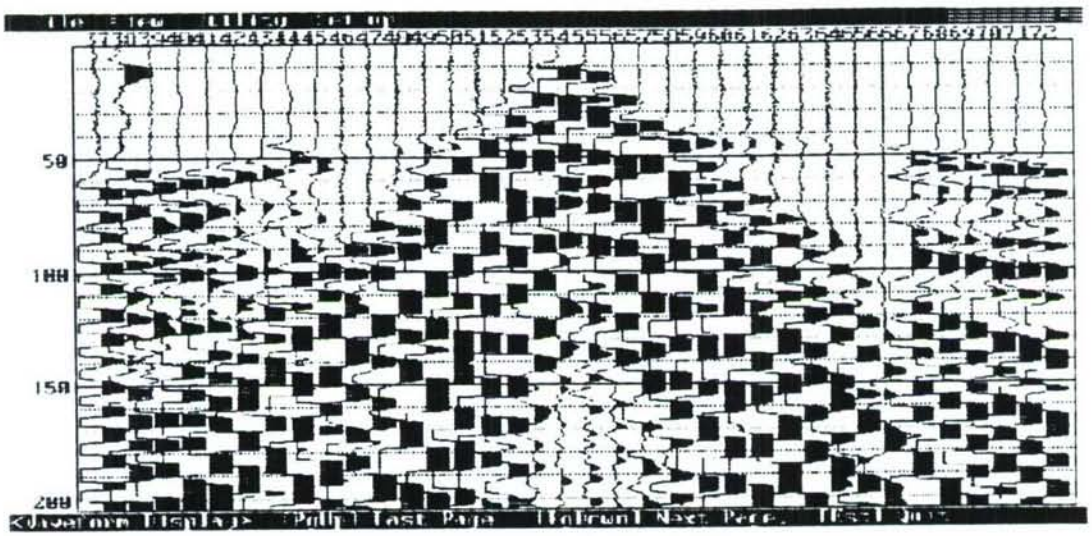
P36/P37 STUDY AREA - SEISMIC LINE SSL-14

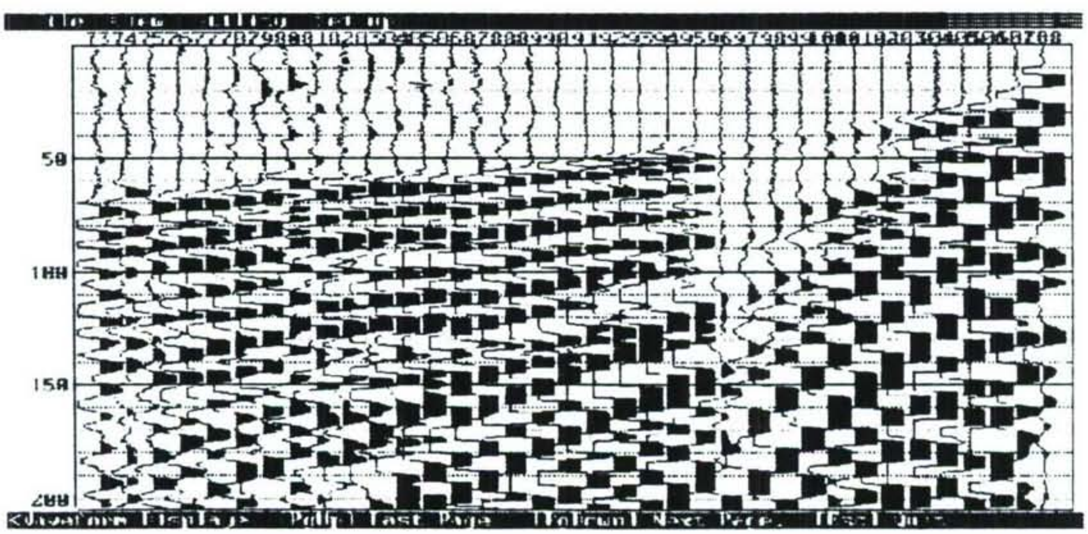


P36/P37 STUDY AREA - SEISMIC LINE SSL-14

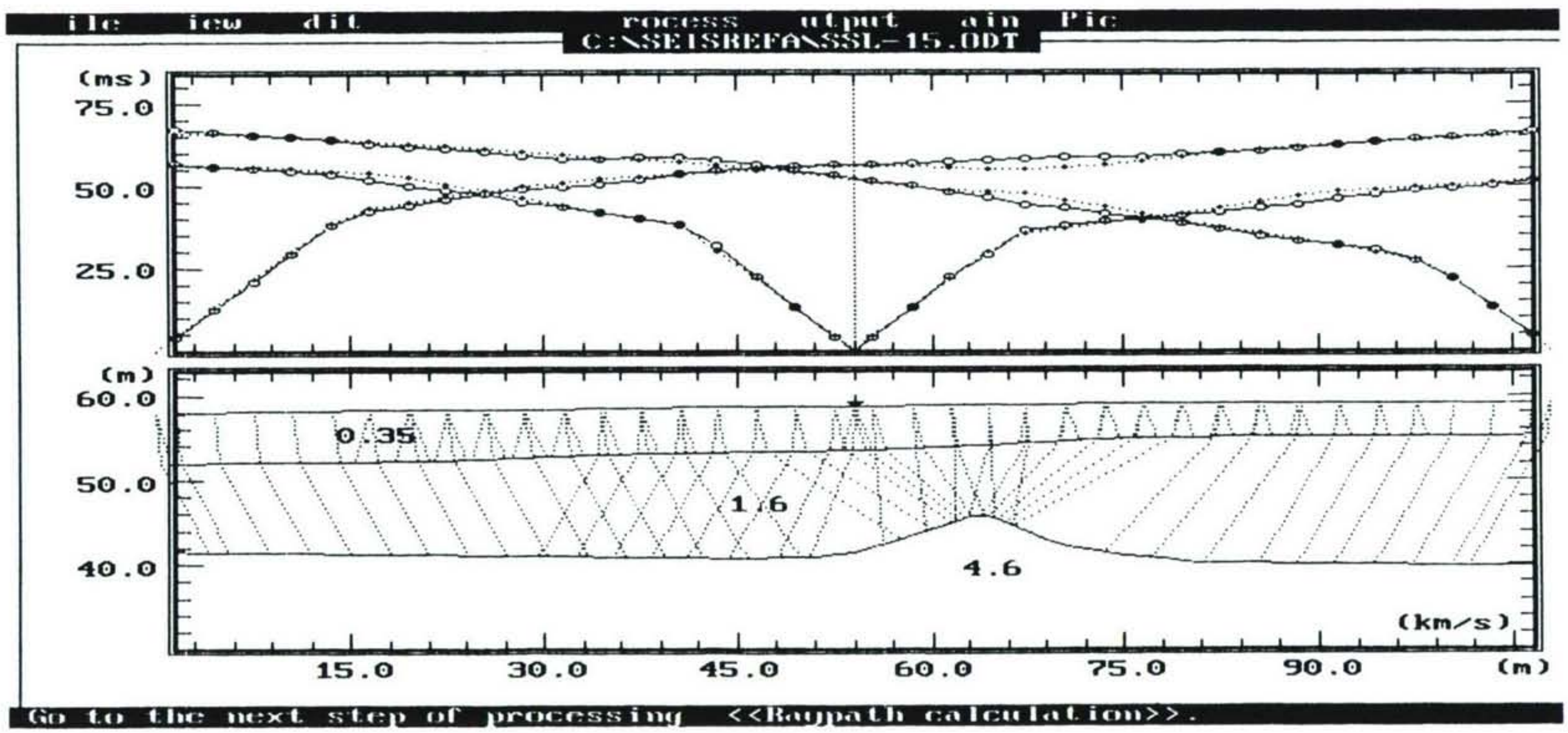
SSL-15





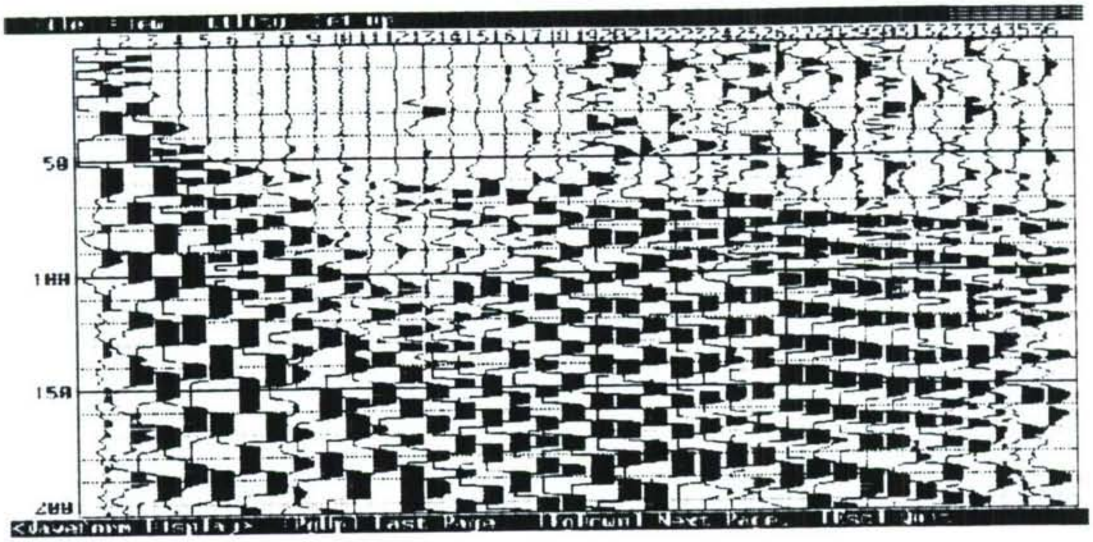


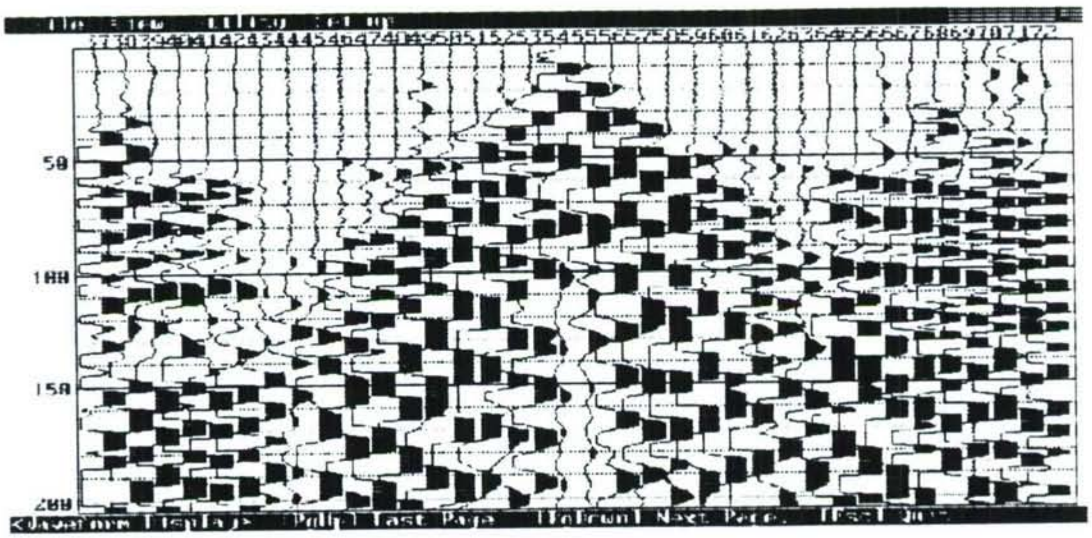
P36/P37 STUDY AREA - SEISMIC LINE SSL-15

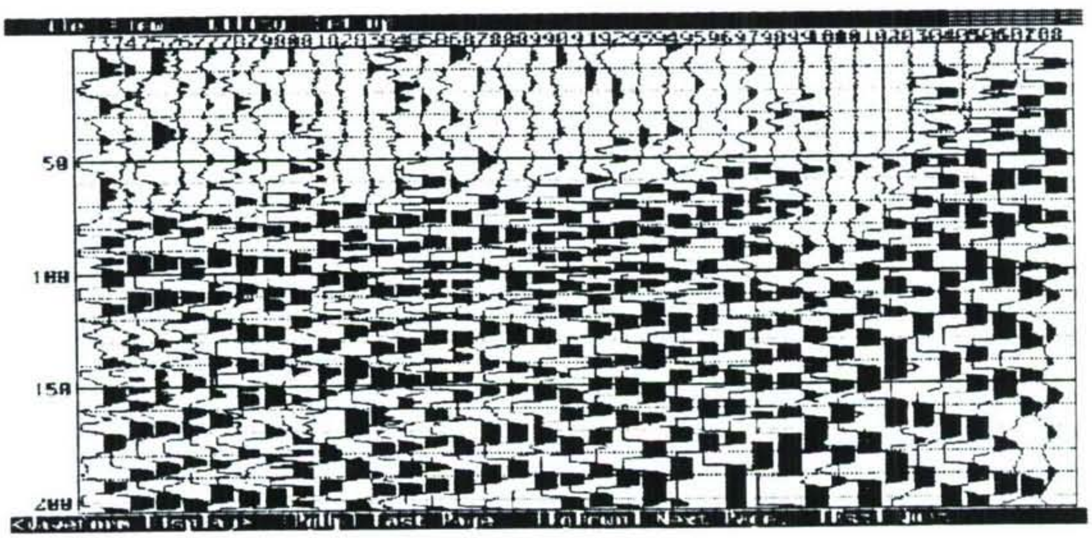


P36/P37 STUDY AREA - SEISMIC LINE SSL-15

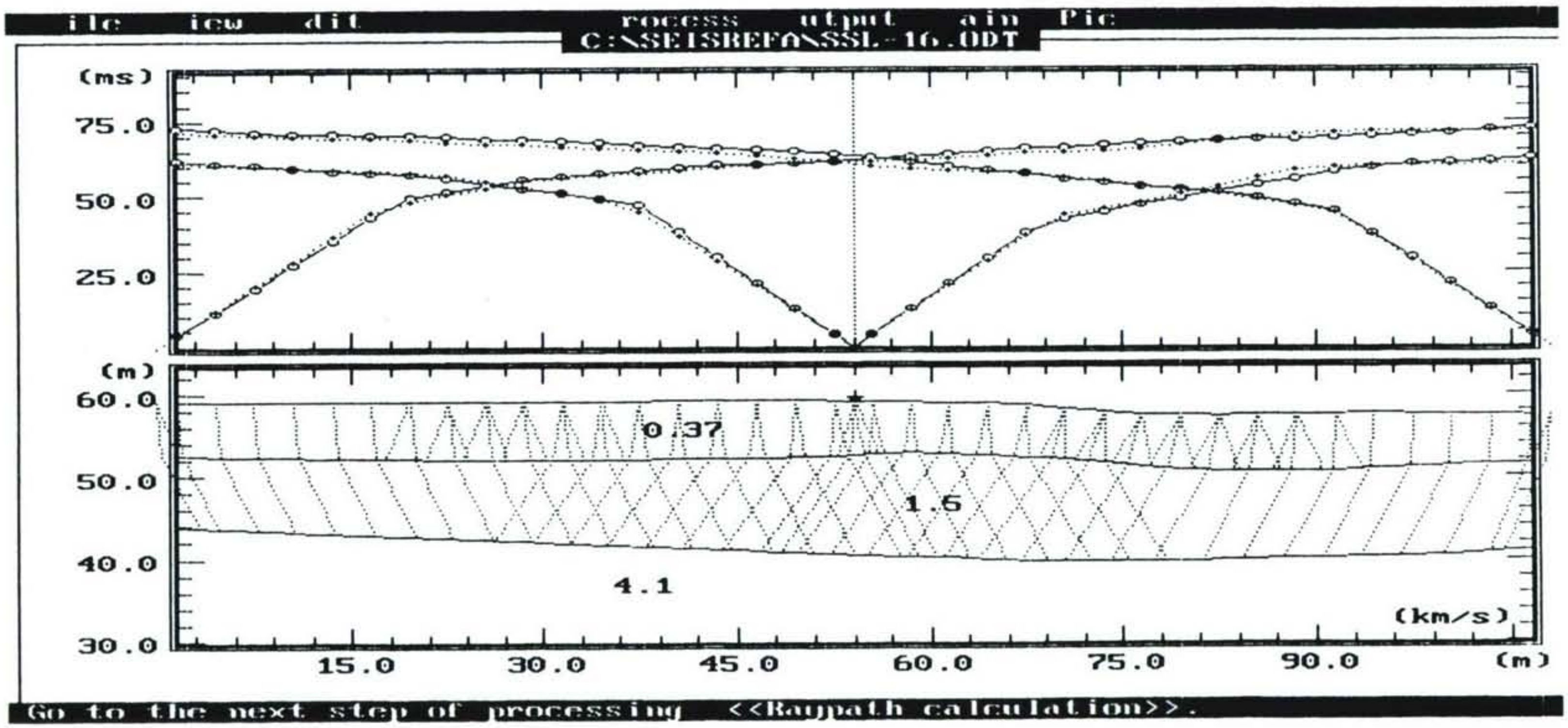
SSL-16





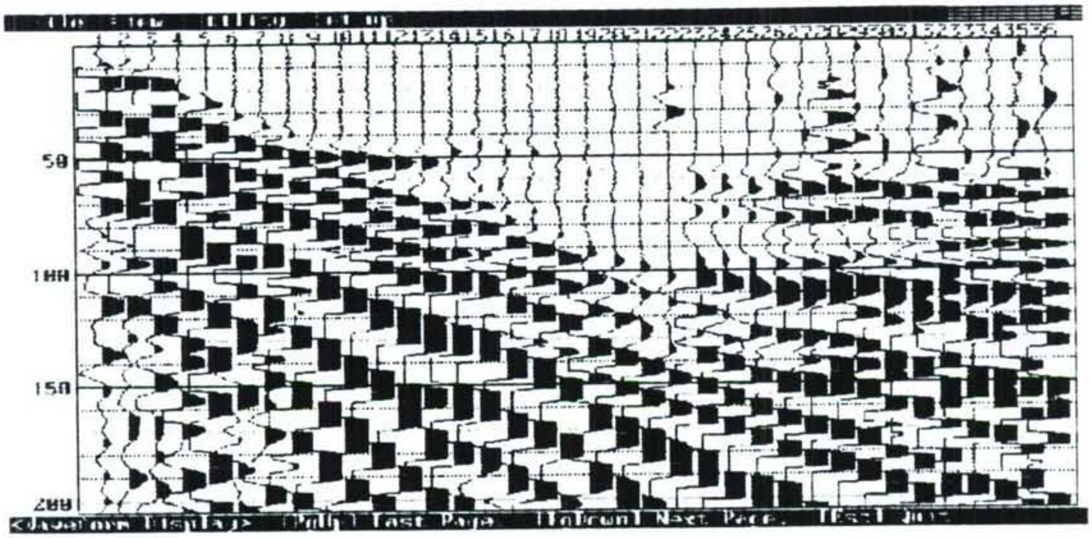


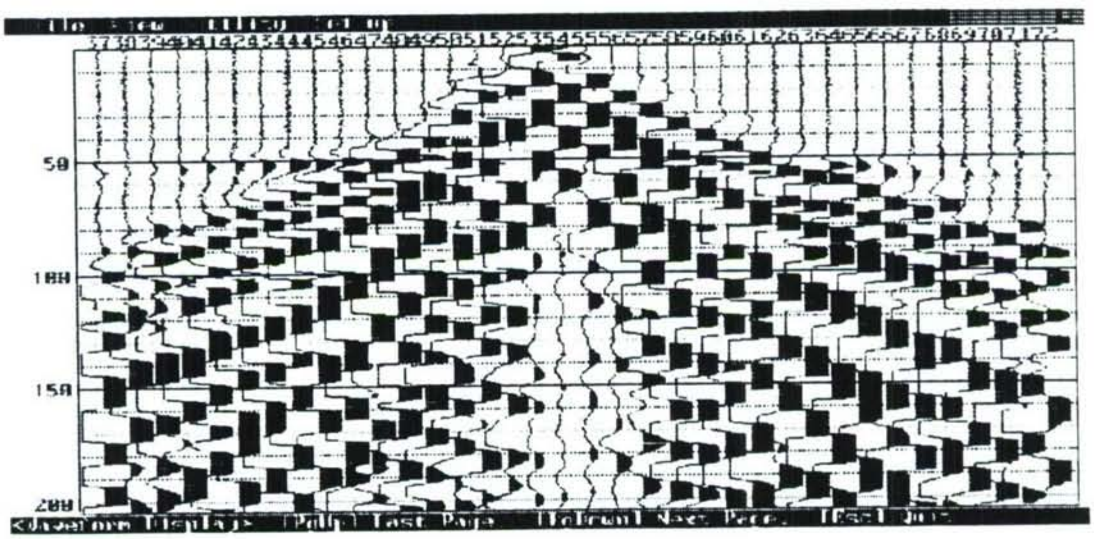
P36/P37 STUDY AREA - SEISMIC LINE SSL-16

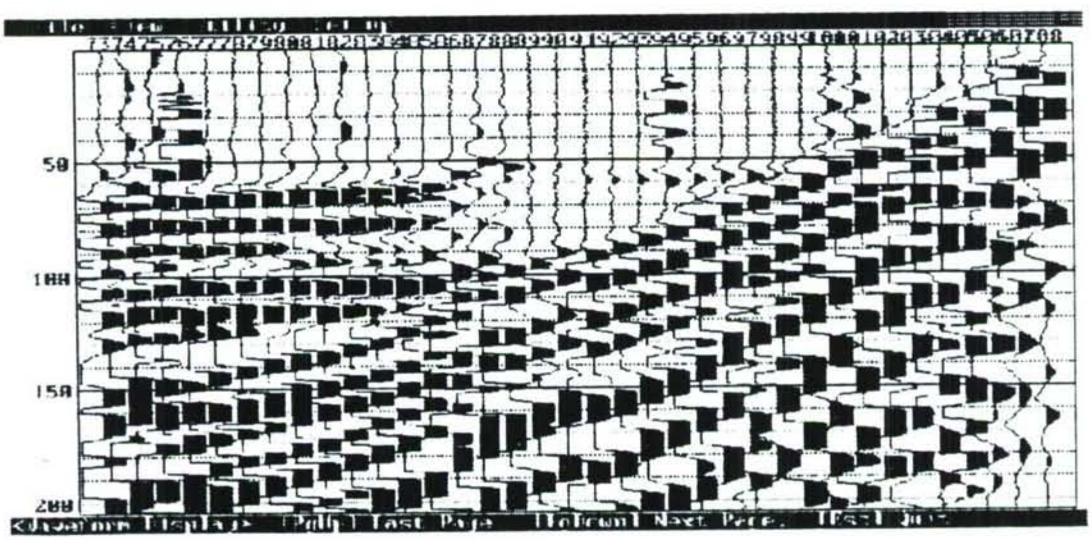


P36/P37 STUDY AREA - SEISMIC LINE SSL-16

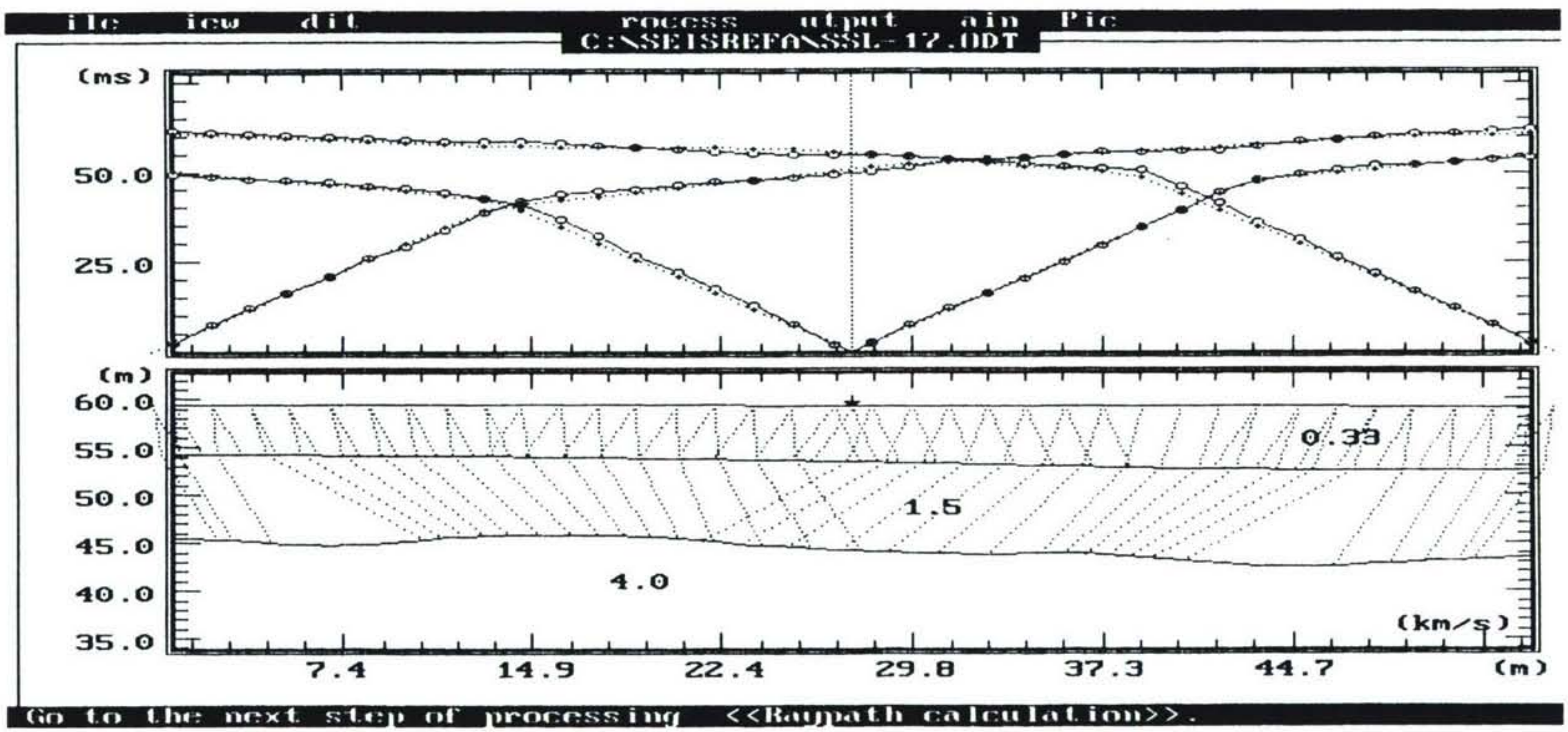
SSL-17







P36/P37 STUDY AREA - SEISMIC LINE SSL-17



P36/P37 STUDY AREA - SEISMIC LINE SSL-17

APPENDIX E

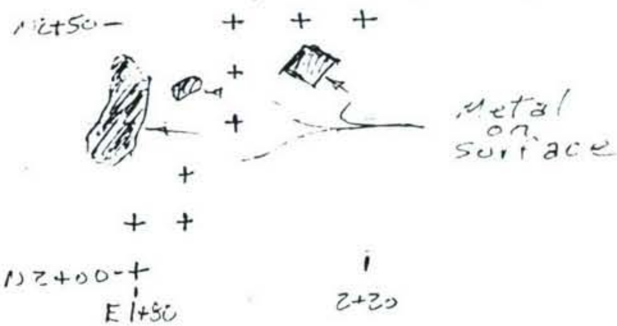
ATTACHMENT F

P22 STUDY AREA
RAW MAG DATA

8 UC6Ø61 8-12-93

- Azimuth: N2+50, E2+00 to N1+00, E2+00 ≅ 205°

1010 - Beginning Mag. Survey.



1235 - Arrive at Trailer, Break for lunch.
1325 - Arrive at P22, resume Mag survey.

1540 - Take quick Break, then lay out more grid.

1610 - Resume collecting Mag. data.

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F22 Mag Data

Station N	Station E	Mag Reading	Comments
1+00	2+00	54592.0	10:19, Base Station (BS)
1+00	1+80	54594	
+10	"	54597	
+20	"	54598	
+30	"	54599	
+40	"	54601	
+50	"	54603	
+60	"	54605	
+70	"	54607	
+80	"	54607	
+90	"	54606	
2+00	"	54598	
2+10	"	54560	Metal @~N 2+22
1+80	1+65	54608	
"	1+50	54609	
"	1+35	54607	
1+50	1+65	54605	
"	1+50	54605	
"	1+35	54603	
1+00	1+90	54594	
+10	"	54595	
+20	"	54596	
+30	"	54601	
+40	"	54604	
+50	"	54605	
+60	"	54604	
+70	"	54606	
+80	"	54608	
+90	"	54608	
2+00	"	54601	

P22 STUDY AREA - MAGNETOMETER DATA, SHEET 1 of 8

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Station N	Station E	Mag. Reading	Comments
2+10	1+90	54586	See page 8, metal location
2+20	"	546~~48~~61	
0+90	2+00	54593	
1+00	"	54595.6	10:50, BS Bush
+10	"	-SKIP-	
+20	"	54599	
+30	"	54601	
+40	"	54604	
+50	"	54604	
+60	"	54605	
+70	"	54605	
+80	"	54608	
1+90	"	54612	
2+00	"	54613	
+10	"	54617	
+20	"	54642	
+30	"	54635	
+40	"	54472	
+50	"	54578	
+60	"	54604	
2+70	"	54632	Well @ N2+78, E1+74
0+90	2+10	54593	
1+00	"	54599	
+10	"	54579	
+20	"	54602	
+30	"	54603	
+40	"	54606	
+50	"	54608	
+60	"	54607	
1+70	"	54601	

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Station N	Station E	Mag. Reading	Comments
1+80	2+10	54606	
1+90	"	54613	
2+00	"	54619	
+10	"	54627	
+20	"	54654	
+30	"	54817	
+40	"	-SKIP-	Metal (CAR Hoods +)
+50	"	54599	
+60	"	54608	
+70	"	54617	
2+80	"	54616	
0+80	2+20	~~54604.0~~	54596
0+90	"	54600	
1+00	"	54602	
1+00	2+00	54604.0	11:23, BS
1+10	2+20	54604	
+20	"	54605	
+30	"	54603	
+40	"	54612	
+50	"	~~54635~~ WB	54616
+60	"	54634	
+70	"	54760	55 731 @ N1+69, E2+23
+80	"	54602	
1+90	"	54617	
2+00	"	54625	
+10	"	54633	
+20	"	54652	
+30	"	54708	
+40	"	54690	
+50	"	54609	

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Station N	Station E	Mag. Reading	Comments
2+60	2+20	54619	
+70	"	54628	
2+80	"	54641	
0+70	2+30	54602	
1+00	"	54603	
+10	"	54605	
+20	"	54606	
+30	"	54608	
+40	"	54609	
+50	"	54611	
+60	"	54621	Note: 55 gal drum has large angle iron in it, vertical.
+70	"	54665	
+80	"	54613	
+90	"	54618	
2+00	"	54626	
+10	"	54632	
+20	"	54640	
+30	"	54647	
+40	"	54637	sheet metal @ N2+45, E2+35
+50	"	54618	
+60	"	54627	
+70	"	54637	
2+80	"	54660	
1+00	2+00	54606.7	11:44, BS
0+90	2+40	54605	
1+00	"	54605	
+10	"	54605	
+20	"	54606	
+30	"	54606	
+40	"	54607	

13

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Station N	Station E	Mag Reading	Comments
1+50	2+40	54611	
+60	"	54612	
+70	"	54612	
+80	"	54617	
1+90	"	54621	
2+00	"	54625	
+10	"	54629	
+20	"	54633	
+30	"	54636	
+40	"	54644	
+50	"	54618	
+60	"	54632	
+70	"	54638	
+80	"	54652	
1+00	2+00	54606.7	11:54, BS
0+90	2+50	54603	
1+00	"	54606	
+10	"	54607	
+20	"	54605	
+30	"	54603	
+40	"	54606	
+50	"	54609	
+60	"	54615	
+70	"	54614	
+80	"	~~54621~~	54617
1+90	"	~~54624~~	54621
2+00	"	~~54627~~	54624
+10	"	~~54631~~	54627
+20	"	~~54634~~	54631
+30	"	~~54636~~	54634

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Station N	Station S	Mag. Reading	Comments
2+40	2+50	~~54626~~	54636
+50	"	~~54636~~	54626
+60	"	~~54637~~	54636
+70	"	~~54641~~	54637
2+80	"	54641	
1+00	2+00	54613.4	12:10, BS
Break for lunch			
1+00	2+00	54620.4	11:03, BS
0+90	2+60	~~54620.4~~	54624
1+00	"	54632	
+10	"	54637	
+20	"	-SKIP-	Brush metal @ N1+32, E2+66
+30	"	-SKIP-	"
+40	"	54619	
+50	"	54627	
+60	"	54629	
+70	"	54634	
+80	"	54634	
1+90	"	54638	
2+00	"	54644	
+10	"	54647	
+20	"	54652	
+30	"	54654	
+40	"	54655	
+50	"	54644	
+60	"	54657	
2+70	"	54659	
0+90	2+70	54627	
1+00	"	54641	
1+11	"	-SKIP-	Brush

GB

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Station N	Station E	Mag. Reading	Comments
1+20	2+70	54551	Metal @ N1+14, E2+75
+30	"	54591	
+40	"	54612	
+50	"	54625	
+60	"	54626	
+70	"	54628	
+80	"	54627	
+90	"	54635	
2+00	"	54642	
+10	"	54649	
+20	"	54653	
+30	"	54656	
+40	"	54656	
+50	"	54655	
2+60	"	54661	
1+00	2+00	54633.3	1426, BS
0+90	2+80	54627	
1+00	"	54647	
+10	"	54728	
+20	"	54562	
+30	"	54605	
+40	"	54615	
+50	"	54622	
+60	"	54622	
+70	"	54616	
+80	"	54616	
+90	"	54624	
2+00	"	54634	
+10	"	54645	
+20	"	54650	

GB

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Station N	Station E	Mag. Reading	Comments
2+30	2+80	54655	
+40	"	54658	
2+50	"	54649	
0+80	2+90	54625	
0+90	"	54626	
1+00	"	54634	
+10	"	54627	
+20	"	54592	
+30	"	54596	
+40	"	54600	
+50	"	54618	
+60	"	54621	
+70	"	54607	~~Small~~ buried metal (small amount exposed)
+80	"	54577	
+90	"	54593	
2+00	"	54616	
+10	"	54637	
+20	"	54647	
+30	"	54655	
+40	"	54657	
2+50	"	54648	
1+00	2+00	54633.4	14:44,
1+00	3+00	54636	
+10	"	54622	Metal, mostly buried @ N1+17, E3+01
+20	"	54480	
+30	"	54589	
+40	"	54552	
+50	"	54614	
+60	"	54617	
+70	"	54573	

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Station N	Station S	Mag Reading	Comments
1+80	3+00	54490	See map, p.20
1+90	"	54542	
2+00	"	54575	
+10	"	54628	
+20	"	54645	
+30	"	54653	
+40	"	54659	
2+50	"	54672	
0+90	3+10	54636	
1+00	"	54661	
+10	"	54745	
+20	"	54624	old washer
+30	"	54616	
+40	"	54677	
+50	"	54652	
+60	"	54712	
+70	"	54913 *	Begin metal N1+72
+80	"	-SKIP-	metal debris
+90	"	54109 *	
2+00	"	54521	
+10	"	54615	
+20	"	54643	
+30	"	54653	
+40	"	54658	
2+50	"	54650	
1+00	2+00	54639.5	15:18, BS
0+90	3+20	54632	
1+00	"	54645	
+10	"	54687	
+20	"	54616	Near metal

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Station N	Station E	Mag Reading	Comments
1+30	3+20	54617	
+40	"	54637	
+50	"	54677	
+60	"	54998	
+70	"	- SKIP -	metal pile
+80	"	- SKIP -	"
1+70	"	54043*	
2+00	"	54503	
+10	"	54608	
+20	"	54635	
+30	"	54652	
+40	"	54656	
2+50	"	54655	
0+90	3+30	54629	
1+00	"	54626	
+10	"	54617	
+20	"	54600	
+30	"	54605	
+40	"	54626	
+50	"	54671	
+60	"	54786	
+70	"	55042	W. edge of metal
+80	"	54585*	
1+90	"	54493	
2+00	"	54562	
+10	"	54617	
+20	"	54638	
+30	"	54651	
+40	"	54655	
2+50	"	54656	GfB

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Station N	Station E	Mag Reading	Comments
1+00	2+00	54639.4	15:36, BS
		Break	
1+00	2+00	54639.0	16:15, BS
0+80	3+40	54627	
+90	"	54631	
1+00	"	54626	See map, p.20
+10	"	54662	"
+20	"	54615	"
+30	"	54576	
+40	"	54612	
+50	"	54641	
+60	"	54666	
+70	"	54685	
+80	"	54605	
1+90	"	54581	
2+00	"	54604	
+10	"	54629	
+20	"	54643	
+30	"	54652	
+40	"	54655	
2+50	"	54653	
0+80	3+50	54623	
0+90	"	54635	
1+00	"	54678	
+10	"	54666	
+20	"	54807*	
+30	"	54557	
+40	"	54591	
+50	"	54621	
+60	"	54631	

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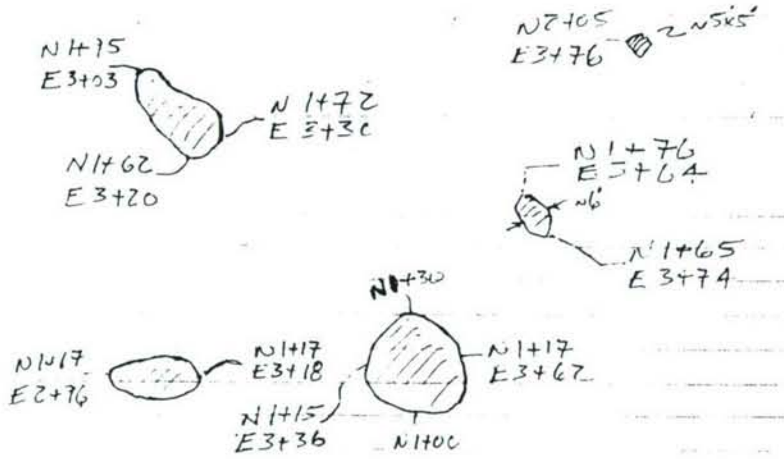
Surface Metal Map



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Station N	Station E	Mag Reading	Comments
1+70	3+50	54628	
+80	"	54616	
1+90	"	54613	
2+00	"	54623	
+10	"	54634	
+20	"	54642	
+30	"	54651	
+40	"	54657	
2+50	"	54645	
1+00	2+00	54639.0	16:38, BS
0+90	3+60	54652	
1+00	"	54613	
+10	"	54633	See page 20
+20	"	54701	
+30	"	54591	
+40	"	54595	
+50	"	54610	
+60	"	54625	
+70	"	54611	
+80	"	54614	
1+90	"	54624	
2+00	"	54628	
+10	"	54624	
2+20	"	54637	
0+90	3+70	54642	
1+00	"	54623	
+10	"	54630	
+20	"	54615	
+30	"	54605	
+40	"	54630	

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Station N	Station E	Mag Reading	Comment
1+50	3+70	54611	
+60	"	54649	
+70	"	54613	
+80	"	54577	See map, page 20
1+90	"	54629	
2+00	"	54627	
+10	"	54631	
2+20	"	54645	
0+90	3+80	54625	
1+00	"	54625	
+10	"	54621	
+20	"	54615	
+30	"	54616	
+40	"	54619	
+50	"	54626	
+60	"	54638	
+70	"	54645	
1+80	"	54649	
1+00	3+90	54621	
+10	"	54620	
+20	"	54615	
1+30	"	54612	
1+00	2+00	54638.5	16:59, BS

LAB

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1705 - Finish P22 mag. survey. Not running EM due to little to be gain from a recon survey or grid survey (considering time needed).

1730 - Tried to find a way to P58. It appears the only / best access is through the gate to P22, follow the dirt road parallel with Patrol Road to a road/trail that ends North of P58 then hike in. Return to Trailer.

1745 - Depart from site.

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APPENDIX F

ANALYSIS OF QA/QC PROGRAM

APPENDIX F

QA/QC ANALYSIS OF LABORATORY DATA

F.1 INTRODUCTION

This appendix provides an overview of all field and laboratory quality control (QC) samples collected during field investigations at the Sudbury Training Annex of Fort Devens, Massachusetts. The QC sample results were downloaded from USAEC's IRDMIS into E & E's Site Master Database and incorporated into data summary tables presented in this appendix.

Data presented here were generated by ESE Laboratories, DataChem Laboratories, and E & E's ASC from the analyses of soil and water samples collected from August of 1993 through January of 1994. The QC sample results were reviewed and assigned with data usability qualifiers as described in Volume I, Section 5.3.3. Each watershed section in Volume II also contains a subsection which provides details of the impact of the QC sample results on the completeness and usability of the data for determining the extent of contamination.

Analyses performed included TAL metals, TCL VOCs, TCL BNAs, TCL pesticides/PCBs, TPHC, explosives, herbicides, organophosphorus pesticides, anions (water only), and TOC (soil only). A summary of methods and recommended method detection limits (RMDL) used by E & E and DataChem, as well as the certified reporting limits (CRL) used by ESE is provided in Table F-1.

The CRL used by ESE defines the lowest concentration of analyte in the sample which can be quantitatively differentiated from zero, with 95 percent confidence, using a complete and specific analytical method for which precision and accuracy criteria are valid. The RMDL used by E & E's ASC and DataChem is based on the method detection limit (MDL), a statistically determined detection limit which defines the lowest concentration detectable for a particular analyte. The MDL is determined by seven consecutive analyses for a given analyte after which the variation in the sample result, a measure of random error in the analyses, at a 95 percent level of confidence, is determined. The value of the t-statistic is then multiplied by the standard deviation of the seven individual measurements to find the lowest concentration that can be differentiated from random error (instrumental interference). The RMDL is chosen to be greater than the MDL for all parameters at a consistent value equivalent to the lowest calibration standard.

F.2 METHOD BLANKS

The analysis of standard matrix method blanks for each analytical lot provides information concerning the possible introduction of laboratory contaminants to the environmental samples. Method blanks consist of a standard matrix that are processed in the same manner as the environmental samples. The standard matrix for soil was provided to the individual laboratories by the USAEC Chemistry Branch and the standard matrix for water was produced by the laboratories according to USAEC guidelines.

Method blanks were analyzed for all parameters within the following analytical tests: TAL metals, TCL VOCs, TCL BNAs, TCL pesticides/PCBs, TPHC, explosives, herbicides, organophosphorus pesticides, anions (water only), and TOC (soil only). Table F-2 provides a listing of the method blanks for each lot in which specific analytes were found. For common laboratory contaminants, sample results less than ten times the blank levels were qualified with a "B". If the compound in the blank was not a common laboratory contaminant, sample results less than five times the blank levels were qualified with a "B". In both cases, the "B" qualifier indicates the sample result is attributable to field or laboratory contamination. If sample results were close to the blank levels (e.g., t to 10 times), the result is qualified with a "K" as biased high.

F.2.1 TAL Metals

Soil method blank results for TAL Metals were not used to qualify data with regard to laboratory contamination because the USAEC Repository Standard Soil had low levels of metals that do not correspond to the native soils surrounding Sudbury Annex. Thus, it was unusable as a background standard and could not be used to determine whether metals found in field samples were from the standard soil matrix or from processing of the samples.

The only metals found in the water method blanks that affected sample data were potassium, sodium, zinc, aluminum, beryllium, and lead. Of these, potassium and sodium can be attributed to the standard water matrix. However, beryllium, zinc, lead and aluminum would not be expected to be in the standard water matrix and are probably attributable to laboratory contamination from analysis reagents or processing of the samples. Beryllium was detected at trace concentrations in only one of the method blanks and lead was detected at trace concentrations in only two method blanks. These findings did not effect the usability of the data since the metals found in the samples were at much higher concentrations. Conversely, aluminum and zinc concentrations found in the method blanks did compare with concentrations found in samples. In all cases, the samples were qualified with either a "K" or "B" as described above.

F.2.2 TCL Volatile Organic Compounds

The following VOCs were detected in the soil method blanks for the Annex: acetone, methylene chloride, toluene, and 2-butanone. These compounds are common laboratory contaminants and their presence is attributable to the laboratory environment. The affected

data were qualified with either a "K" or "B" as described above. Xylenes were also detected in one blank, but not in any samples.

In addition to methylene chloride and acetone, the TCL VOCs found in the water method blanks were chloroethane, chloroform, and carbon disulfide. Although none of these compounds are considered to be laboratory contaminants, their presence is attributable to the laboratory background or artifacts from the preservation of samples. The associated sample data were qualified as described above, but the compounds were generally not found in the samples.

F.2.3 TCL Base Neutral Acid Extractables

The TCL BNAs and tentatively identified compounds (TICs) that were routinely detected in the method blanks are *bis*(2-ethylhexyl)phthalate, butyl benzyl phthalate, diethyl phthalate, and di-*N*-butyl-phthalate. Phthalates are associated with plastic products and can therefore be attributed to laboratory and field contamination. The remaining compounds (C35, C36, and Linola) are TICs and are estimated quantitatively. Most likely these are artifacts from laboratory procedures. For all cases, with the exception of the TICs where parameter concentrations in the method blanks compared to the sample concentrations, the sample data were qualified with a "B" as described in Section 5.3.3.

Other TCL BNAs were detected in a single method blank. The results appear to be attributable to laboratory background or glassware carryover and did not affect sample results.

F.2.4 TCL Pesticides/PCBs

TCL pesticides which were detected in the soil method blanks include: alpha-BHC, alpha-chlordane, alpha-endosulfan, aldrin, beta-endosulfan, delta-BHC, dieldrin, endrin, endrin aldehyde, endosulfan sulfate, gamma-chlordane, heptachlor, heptachlor epoxide, lindane, DDD, DDE, and, DDT. Affected data were qualified as described in Volume I, Section 5.3.3.

There were no confirmed detections of pesticides in any of the water method blanks. Several compounds present at trace concentrations due to laboratory background, co-eluted with pesticides on the primary column, but these compounds were not detected on a secondary column. As a result, no data were qualified based on the water method blanks for these compounds.

There were no TCL PCBs detected above the MDL in any of the soil or water method blanks.

F.2.5 Total Petroleum Hydrocarbons

TPHC was not found in either the soil or water method blanks.

F.2.6 Explosives

There were no explosives detected above the MDL in any of the soil method blanks.

The only explosive above the RMDL in the water method blanks was 4-amino-2,6-dinitrotoluene and results were qualified accordingly.

Several nitrotoluene compounds were detected and initially reported as estimated values below the RMDL in both the method blanks and samples. A QA/QC review of the explosives data indicated that the nitrotoluene compounds could not be accurately identified or quantified below the RMDL. Therefore, all explosives below the RMDL that were not confirmed on a second column were reported as less than the RMDL and were not used for evaluating contamination. Cyclonite was also detected in the water method blank below the RMDL for only one explosives lot. Since Cyclonite was only found in samples within this lot below the RMDL, no data were qualified. Overall, because Cyclonite was detected in many blanks and samples at concentrations below the RMDL, the results were judged to be too low and undifferentiable from background interference. Consequently, all unconfirmed sample data for Cyclonite with results below the RMDL were reported as less than the RMDL.

F.2.7 Total Organic Carbon

There was no carbon found in any of the TOC method blanks.

F.3 RINSATE BLANKS

Rinsate blanks are field QC samples that are used to provide information on the potential for sample contamination from disposable field equipment or from carryover from ineffective decontamination of reusable equipment. Rinsate blanks are collected by flushing analyte-free water over the sampling equipment into sample bottles and then preserving the rinsate blank sample as a normal sample. The "analyte-free" water used was obtained through Fisher Scientific or VWR Scientific as deionized, ultra-filtered reagent water. These samples are then analyzed for the same parameters as the samples for the associated area.

Rinsate blank samples were assigned for each matrix. The types of equipment for which rinsate samples were collected were: teflon bailers which were used for groundwater samples, stainless-steel split spoons used for subsurface soil sampling from borings, disposable aluminum pans sometimes used for surface soil and sediment sampling, and the backhoe shovel which was used for most of the excavation samples. The analytes which were found in the rinsate blanks collected at the Annex are listed in Table F-3 and can be differentiated by a "R" in the second character of the field sample number. If sample results were not previously qualified from method blank contamination, the samples associated with rinsates were qualified as described in Volume I, Section 5.3.3.

F.3.1 Soil Samples Rinsates

Soil rinsates were broken into two groups: surface soil/sediment and excavation/subsurface soils, based on sampling technique and equipment used.

F.3.1.1 Surface Soil/Sediment Rinsates

There were four rinsate samples collected (DR2601X1, DRBCK021, DRPUF011, and DRP13012) for the sediment samples collected at the Sudbury Training Annex. The only analytes found in these rinsate blanks were: antimony, cadmium, potassium, zinc, 1,1,1-trichloroethane, acetone, methylene chloride, di-*N*-butyl-phthalate, carbon disulfide, and chloroform. All of the metals found were detected at trace levels below their respective RMDL and qualified as estimated. The volatile organics were all considered to be due to laboratory contamination or were found at trace levels below their RMDL. Heptachlor was detected but was unconfirmed by a second column and was qualified as unconfirmed and flagged with a "U". Di-*N*-butyl-phthalate was also considered due to field or laboratory contamination due to plasticizers. The presence of the trace level of cadmium and zinc were most likely caused by interelement interferences on the ICP instrument. The presence of antimony was probably a laboratory artifact and potassium was attributed to the "analyte-free" water used to collect the rinsate.

There was one rinsate blank sample collected (SR4201X1) for the surface soil samples collected at the Sudbury Training Annex. Surface soil samples were collected by homogenizing the samples in the ground or in disposable aluminum pans with disposable stainless steel spoons. The analytes detected in the rinsate sample were sodium, potassium, acetone, methylene chloride, and di-*N*-butyl-phthalate. The presence of potassium and sodium was attributed to the "analyte-free" water used to collect the rinsate sample and were both found below the RMDL. The volatile organics and di-*N*-butyl-phthalate were most likely a result of laboratory contamination.

F.3.1.2 Excavations/Subsurface Soil Samples Rinsates

There were four rinsate blank samples collected for excavation samples collected at the Annex (ERA08011, ERA11011, ERP31011, and ERP56011). Analytes found in these samples included 2,4,5-T, aluminum, methylene chloride, chloroform, carbon disulfide, di-*N*-butyl phthalate, iron, heptachlor, heptachlor epoxide, total phosphorus, and zinc. The pesticide results were not confirmed and these detections along with other compounds are attributable to laboratory background. However, the only analytes which were found to affect sample data above the method blank concentrations were acetone, and zinc.

There were nine rinsate samples collected to provide field QC for the subsurface soil samples collected at the Annex. The following parameters were detected in these rinsates samples: aluminum, sodium, zinc, potassium, iron, manganese, arsenic, lead, copper, methylene chloride, acetone, bis-2-ethylhexyl phthalate, di-*N*-butyl phthalate, 1,1,1-trichloroethane, and the TICs Hedoda and Linola. The presence of the methylene chloride,

acetone, and the phthalates were all considered present due to laboratory contamination. Linola and 1,1,1-trichloroethane were both found to be present due to laboratory contamination or the source water and were qualified with a "B". Most of the metals found were considered due to the blank or were found at trace levels below the RMDL. The only exceptions were iron at 410 μg/L in BRP01042 and at 87 μg/L in BR3701X1, aluminum at 45 μg/L BR0201X1 and arsenic and lead at 2.67 μg/L and 17.2 μg/L, respectively, in BR3801X1. Of these only arsenic and lead were unexpected, and only the data for lead for BX380101 and BX380101 were qualified as present due to the blank.

F.3.2 Water Samples Rinsates

Rinsate blank samples for the water matrix were only collected for groundwater samples. Filtered and unfiltered samples were collected to adequately monitor the two sample types.

F.3.2.1 Unfiltered Rinsates

Six unfiltered rinsate samples were collected at the Annex. Analytes found in the analytical results of the rinsate samples included 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-dinitrotoluene, acetone, silver, methylene chloride, chloroform, carbon disulfide, di-*N*-butyl phthalate, heptachlor, lindane, DDT, and TPHC. Of these only TPHC and heptachlor affected sample data which were appropriately qualified with a "B" to indicate field or laboratory contamination as described in Volume I, Section 5.3.3. It is possible that their presence may be due to carryover from the laboratory apparatus used in the analysis. The other analytes detected were probably due to isolated incidents of laboratory background contamination or the source of analyte-free water, but data were not affected.

F.3.2.2 Filtered Rinsates

There were five filtered rinsate QC samples collected for the 61 filtered samples collected at the Annex representing 8.2 percent of the samples. Only antimony and iron found in one filtered rinsate sample were determined to affect the corresponding sample data. The presence of these metals is probably due to particulate matter smaller than the 0.45 micron pore size filters used or to dissolved metals in the source of analyte-free water. Other analytes found in the rinsate samples which had no effect on sample data were: beryllium at trace concentrations, aluminum, zinc, manganese, calcium, lead, and magnesium. These are all probably attributable to either laboratory contamination or the analyte-free water used.

F.4 TRIP BLANKS

Trip blanks are field QC samples used to monitor volatile organic contamination occurring during shipment of samples. They are samples of deionized ultrafiltered water that have been preserved as a volatile sample to accompany the sample bottles to the sampling location, and then are shipped with the samples to the laboratory. Trip blanks are shipped for

each matrix at a frequency proportional to the number of VOC samples collected. Care is taken so that every sample for TCL VOCs has a trip blank to which it was associated.

A total of fifty-eight trip blank samples were shipped with VOC samples collected at the Annex. VOC samples were packaged in a single cooler and were accompanied by a trip blank for each matrix. Only four analytes were found in the trip blanks: acetone, methylene chloride, carbon disulfide, and 1,1,1-trichloroethane. Only two samples and three QC samples were affected (BX360302, EXP26042, BR3801X1, BR4801X1, and DR2601X1). The first three compounds are common laboratory contaminants and would be expected to be found in samples analyzed for TCL VOCs. Trip blank samples results are presented in Table F-4 and can be differentiated by a "V" in the second character of the field sample number. The presence of 1,1,1-trichloroethane appears to be related to the source of analyte-free water as exhibited by the rinsate data.

F.5 FIELD DUPLICATE SAMPLES

Field duplicate samples are collected, handled, shipped, and analyzed in the same manner and for the same parameters as the sample to which they compare. These samples provide a measure of the precision of the sampling and analysis procedures.

Precision is determined through the calculation of relative percent difference (RPD) between the analytical results of the field duplicate and the normal sample. The RPDs were reviewed to determine which data were outside the RPD control limits set by the EPA Inorganic or Organic Guidelines. For inorganic analyses, the limits are ±30 percent for water samples and ±50 percent for soil samples for sample results greater than 5 times the MDL. For organic analyses, the control limits used are ± 2 times the MDL for water samples and ±4 times the MDL for soil samples. For organic analyses, the control limits used for water samples was ±30 percent for water samples and ±50 percent for soil samples. In circumstances in which these limits were not met, the samples were qualified as estimated.

There are also circumstances in which a RPD value could not be calculated because one sample result was above the RMDL and one sample result was reported below the RMDL. These occurrences have been reviewed on a case by case basis. In samples for which the result is below 2 times the RMDL for water samples or 4 times the RMDL for soils, the result is considered to be comparable to the RMDL and these data were not qualified. For cases in which the detected sample concentration was found above these levels, the data were qualified as estimated because the result is considered to be significantly different than the RMDL.

Field duplicate samples results are found in Table F-5 and are differentiated from the original sample by the letter "D" in the second character of the field sample number. Affected data are listed in Table F-3.

F.5.1 Soil Duplicate Samples

There were twenty-one field duplicate pairs for soils collected at the Annex to monitor field and analytical technique; four of which were collected for sediment three for subsurface soils, and fourteen for surface soils.

In the duplicate pair collected at E3-P31-B01, (EXP31012/EDP31012), aluminum, iron, and alpha-BHC exceeded RPD criteria with values of 57.5 percent, 59.9 percent, and 66.7 percent respectively. As a result, aluminum and iron for each subsurface soil sample collected for Watershed 5 was qualified as estimated. Alpha-BHC for only that duplicate pair was qualified as estimated as per USEAC Guidelines. For duplicate pair (BX370302/BD370302), only TOC was found to exceed RPD criteria with a value of 58.2 percent. As a result TOC in these two samples was qualified as estimated.

RPD criteria were exceeded for three compounds (DDT, DDE, and DDD) in the duplicate pair (DXBCK021/DDBCK021) with values of 127.3 percent, 160.0 percent, and 165.6 percent respectively. As a result, these analytes in these two samples were qualified as estimated. For duplicate pair (DXPUF021/DDPUF021), only selenium and DDD fell outside of guidelines for duplicate samples. Selenium had an RPD value of 54.0 percent and was qualified as estimated throughout the watershed. For DDD, only DXPUF021 was found above the RMDL at a concentration of 0.065 μg/g as compared to the RMDL of 0.010 μg/g. Since the concentration found in DXPUF021 was greater than four times the RMDL, the duplicate pair was considered to fail precision criteria and was qualified as estimated. There were two analytes which did not meet precision criteria for duplicate pair DD1301X1/DX1301X1. Copper was qualified as estimated for every sediment sample in the watershed because its RPD was 115.5 percent. Likewise, iron was qualified as estimated for all sediment samples in the watershed because its RPD was 166 percent.

Of the fourteen surface soils duplicates collected at the Annex, eight duplicate sample pairs contained analytes which were qualified based on RPDs. The duplicate pair from E3-P09-S01 (SDP09011/SXP09011) contained three analytes which did not meet RPD criteria. These were benzo(a)anthracene, endrin, alpha-chlordane, and gamma-chlordane. Each was qualified in both samples as estimated. Only beta-endosulfan in the duplicate pair SXP22011/ SDP22011 was assigned a data usability code of "J" for estimated due to its RPD value of 66.7 percent. Four pesticides from the duplicate pair from E3-P06-S01 (SXP06011/SDP06011) were qualified as estimated due to RPD values which exceeded criteria levels. These analytes and RPD values were: dieldrin (66.7%), endrin (100%), lindane (66.7%), and DDT (94.7%). Analytes which were qualified as estimated from SXP45011/SDP45011 were beta-endosulfan, endrin, DDD, and DDT. The RPDs for these analytes in this duplicate pair were 100 percent, 133 percent, 120 percent, and 66.7 percent respectively. The duplicate pair from E3-P16-S01 (SXP16011/SDP16011) exhibited poor precision since the RPDs for eight analytes exceeded guidelines. Analytes in these samples which were affected included benzo(a)anthracene, phenanthrene, dieldrin, beta-endosulfan, DDD, DDE, DDT and TOC. In the duplicate pair from E3-P57-S01, six analytes did not meet precision criteria and were subsequently qualified in the samples as estimated. These

analytes were anthracene, benzo(a)anthracene, benzo(ghi)perylene, indeno(1,2,3-cd)pyrene, DDE, and DDT. The last duplicate pair for which analytes did not meet RPD criteria was (SX3601X1/SD3601X1). DDE and alpha-chlordane had RPD values of 98 percent and 55.6% respectively. As a result, these analytes in these samples were qualified as estimated.

F.5.2 Water Duplicate Samples

Duplicate samples were collected for both surface water and groundwater samples. Furthermore, groundwater duplicate samples were collected for both unfiltered and filtered samples.

F.5.2.1 Unfiltered Duplicates

There were four duplicate samples collected for surface water samples. Three duplicate pairs exhibited at least one analyte which was qualified as estimated because its RPD fell outside of RPD QC criteria. The first such set was (WXP11012/WDP11012) for aluminum (33.7%), barium (39.8%), and iron (41.9%). Each was qualified for all surface water samples within the watershed. The second set was (WXBCK021/WDBCK021) for aluminum (87%), iron (65.5%), and total phosphorus (126.1%). Each of these analytes were qualified as estimated for all surface water sample results, above the RMDL, within the watershed. For duplicate pair (WX2601X1/WD2601X1), only aluminum barely fell outside of RPD criteria and all aluminum results above the RMDL for Watershed 1B were assigned data usability codes of "J".

There were nine unfiltered groundwater duplicate pairs collected at the Annex for the two rounds of groundwater sampling. Analytes which were qualified in at least one of these pairs from round one include: antimony, alpha-BHC, aluminum, 1,3-dinitrobenzene, chromium, and arsenic. For duplicate pair MXP03011/MDP03011, antimony had a RPD value of 79.1 percent and alpha-BHC had a RPD value of 88.0 percent. Consequently, all groundwater samples collected from Watershed 6 in the first round were qualified as estimated for antimony, but alpha-BHC was qualified as estimated for only those two samples as per EPA guidelines. RPD values for 1,3-dinitrobenzene (35.6%), aluminum (37.8%), and alpha-BHC (145.9%) fell outside of RPD criteria in duplicate pair MXP58011/MDP58011. Only the duplicate pair samples were assigned data usability codes of "J" for alpha-BHC and 1,3-dinitrobenzene, but all groundwater samples from Watershed 5 were qualified as estimated for aluminum. The only other analyte which was qualified from the first round of groundwater sampling was arsenic from duplicate pair MX1101X1/MD1101X1. As a result, all samples from Watershed 1B were qualified as estimated for round one.

In duplicate pair MXP58012/MDP58012, aluminum (148.1%), arsenic (151.3%), barium (33.1%), iron (90.4%), magnesium (95.8%), nickel (107.5%), vanadium (124.9%), zinc (31.1%), and total phosphorus (188.3%) were found to exceed RPD precision criteria. As a result, all Watershed 5 groundwater sample results greater then the RMDL for round 2 were qualified as estimated for these analytes. RPD precision criteria was exceeded in only one other duplicate pair for round 2 (MXP31012/MDP31012) and for only one other analyte,

aluminum. However, since aluminum had already been qualified for round two due to the duplicate pair from E3-P58-M01, no additional data were qualified.

F.5.2.2 Filtered Duplicates

The only analyte which was found to exceed RPD precision criteria in either round of groundwater sampling was antimony from duplicate pair MD1101F1/MF1101X1. As a result, only antimony found above the RMDL in round 1 filtered groundwater samples from Watershed 1B were qualified as estimated.

F.6 MATRIX SPIKE/MATRIX SPIKE DUPLICATES

Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples are collected and analyzed as a means of determining the physical effects of the matrix on the analytical results. MS/MSD samples were only collected for methods in which surrogate compounds were not used including TCL pesticides/PCBs, TAL metals, and explosives. The results of the 32 MS/MSD samples of various sample types collected at the Annex can be found in Table F-6.

The MS/MSD samples were evaluated on the basis of RPD values and percent recoveries as described in Volume I, Section 5.3.3. Control limits used for percent recovery for inorganic parameters were 75 percent to 125 percent. Control limits for organic parameters were based on limits established in the laboratory. Data exceeding these limits were qualified as estimated, "J", unless the recovery was below 30 percent for inorganics or 10 percent for organics and less than the RMDL/CRL. In these cases, the data were qualified as rejected and unusable, "R". Data for which the spiking amount was less than four times the native concentration were not qualified due to the difficulty of assessing the percent recovery in these cases.

Across all sample types collected at the Annex, only the following analytes exceeded precision criteria in at least one MS/MSD sample: silver, lead, antimony, selenium, mercury, manganese, aluminum, arsenic, chromium, dieldrin, DDT, 1,3,5-trinitrobenzene, endrin, lindane, cadmium, 2-nitrotoluene, barium, thallium, zinc, alpha-endosulfan, aldrin, dieldrin, heptachlor, cobalt, nickel, calcium, and nitrobenzene.

The compound 1,3,5-dinitrobenzene was found to exceed control limits in only one MS/MSD sample (EXA11011). As a result all excavation samples from Site A11 were qualified as estimated because of low recoveries.

Likewise, 2-nitrotoluene exhibited low recoveries in only one MS/MSD sample set (WXBCK011). As a result, all facility wide surface water samples were qualified as estimated.

Silver was found to fall outside of control limits in the following MS/MSD samples: SX0201X1 due to a low recovery, and SXP54011 due to a low recovery. In all cases, all similar samples from each area were qualified as estimated.

Aluminum was estimated in samples WXA05011 and MXP22011 due to a high MS recovery.

Aldrin was assigned the data usability qualifier, "J", in soil samples from Site P02 because of low recoveries.

Arsenic was found to exceed precision criteria at six sites: P37, Puffer Pond, A06, Background, P02, and P54. However, of all samples, only the borings samples from Site P37 were qualified due to a low matrix spike recovery. All other samples were unaffected because arsenic was found in the method blank.

Barium was qualified as estimated only in water samples from Site P36, Background, and P37. In groundwater samples from Site P36, samples were qualified as estimated because of a high matrix spike recovery. Surface water samples from both background and Site P37 were qualified as estimated due to a low matrix spike recoveries.

Calcium was only found to exceed MS/MSD precision criteria in only one MS/MSD sample WXP37011. Due to a low matrix spike recovery, all surface water samples collected at Site P37 were qualified as estimated.

Samples for which cadmium data were estimated due to low matrix spike recoveries included sediments from Puffer Pond and surface waters from Site P58.

Cobalt data was qualified as estimated for surface soils samples at Site P28, and for surface water samples from Site P58. In each case, matrix spike recoveries were low.

Although chromium data at Site A06 exceeded precision criteria for surface soils, no data were affected because chromium was found in the method blank.

Mercury data was found to exceed precision criteria for borings samples at Site P37, sediments samples from Site A05, filtered groundwater samples from E3-P57-M01 in sampling round 2, and surface water samples from Site P58. In all cases, data for mercury were qualified as estimated due to low matrix spike recoveries, except for Site P58 which was qualified as estimated due to a high matrix spike recovery.

Dieldrin data was affected in only two samples (SXA06011 and SXA06081) due to inconsistent recoveries observed for the matrix spike and matrix spike duplicate. Only two samples were affected because all other soil samples from Site A06 were unconfirmed. Likewise, sediment samples from P37 would have been affected except these too were unconfirmed for dieldrin.

Endrin data were qualified as estimated due to inconsistent recoveries in the matrix spike and matrix spike duplicate samples from sediment samples from two sites: background and P37.

Alpha-endosulfan was found to have inconsistent recoveries between each of the MS/MSD samples from one sample only (DXP37021). As a result this compound was qualified as estimated.

Lindane was qualified as estimated for background sediment samples only due to high recoveries in the matrix spike and matrix spike duplicate analyses.

Magnesium in the matrix spike for groundwater samples taken from Site P36 had high recoveries, and for surface water samples taken from Site A05 had low recoveries. As a result magnesium data for three groundwater samples and one surface water sample were qualified as estimated.

Only surface water samples from Site P37 exceeded precision criteria due to low recoveries in the matrix spike for manganese. As a result, the three surface water samples from Site P37 were the only samples qualified.

Nitrobenzene data was affected in only one surface water sample (WXP58012) due to low recoveries.

Nickel recoveries in the MS/MSD sample BX360301 were high. As a result borings samples data from Site P36 were estimated.

Lead data from seven sites were found to be affected by low recoveries. These sites included sediment samples from background, and Site P57, surface soil samples from Site A02, Site P28, Site P38, and Site P54, and groundwater data from well E3-A10-M01 collected in the second sampling round. In each case, all appropriate data was qualified as estimated.

Data from four sites (P37, P57, P28, and A06) were found to exceed precision criteria for DDT. The MS/MSD recoveries for DXP37021 were low which only affected sample DXP37031 since the samples DXP37011 and DXP37021 were unconfirmed. Sediment sample DXP57011 was qualified as estimated due to high recoveries as were the soil samples from Site A06. Soil samples from Site P28 were estimated due to inconsistent recoveries for DDT in the MS/MSD sample SX2801X1.

Antimony data from borings samples collected from Sites P36 and P01 were qualified as estimated due to low recoveries. Likewise excavation sample data from Sites A11, and P38 were qualified as estimated due to low recoveries. Soil sample data from Sites A02, P38, A06, background, P02, and P54 were also qualified due to low recoveries in the matrix spike. Groundwater sample data which were qualified as estimated due to low matrix spike recoveries were from Sites A10, P03, and P36. The only data which were affected due to high recoveries was a single sediment sample from Site P57 (DXP57011).

Selenium data from borings at Sites P36 and P01 were qualified as estimated due to low matrix spike recoveries. Selenium data from only one sediment sample (DXP57011)

exceeded precision criteria. Since the matrix spike recovery was low, this data was estimated. The only excavation selenium data which were qualified as estimated were from Site P38 due to low recoveries. All groundwater selenium data which were qualified as estimated from MS/MSD precision review were due to low matrix spike recoveries Sites affected were A10, P02, P03, and P36. Selenium data for soils samples from Sites A02, P38, A06, background, and P02 were qualified due to low matrix spike recoveries.

Only background surface water sample data were affected by low recoveries for thallium in the matrix spike sample. As a result these samples were qualified as estimated.

Zinc was found to exceed precision criteria in samples from only one site (Site P02). As a result of high zinc recoveries in the matrix spike, all surface soil samples were qualified as estimated for zinc.

F.7 SURROGATE SPIKES

Laboratory performance on individual samples is established by means of surrogate spikes. Surrogate compounds are added to every sample and blank sample prior to sample preparation. The evaluation of the results of these surrogate spikes is based upon control limits established by the laboratory in compliance with the USAEC QA Guidelines (May, 1993). Since the effects of the sample matrix frequently cause results to be outside laboratory control, surrogate spiking results that were considered acceptable in the laboratory control samples but not in the natural matrix were attributed to matrix effects. However, when the surrogate results were determined to be outside the established limits in the natural matrix as well as the laboratory control sample, an analytical problem was considered at fault. Therefore, the review and validation of data based on specific analytical results demands acute analytical experience and superior professional judgement.

Surrogate spiking data is summarized in Table F-7. All data was qualified for the surrogate spiking sample results by the laboratory with additional qualification assigned by the USAEC after review of weekly control chart submittals.

F.8 LABORATORY CONTROL SAMPLES

Laboratory control samples were run with each lot as described in Volume I, Section 5.3.3 and the QAPjP. The samples consisted of standard matrices spiked with a known quantity of analyte. If the standard matrix spike recoveries were outside of control limits, the samples were re-analyzed. If the holding time was exceeded and the samples could not be re-analyzed, the samples were recollected in the next field event if possible. The samples which were recollected are described in the field sampling section for each site. Samples which could not reanalyzed or recollected were qualified by the USAEC Chemistry Branch and evaluated as part of the QA review. Most of the samples were either analyzed within acceptable control limits or were resampled.

For lots AAZR and AAVX, the standard matrix soil method blank analyzed with each lot exhibited varying low levels of zinc, The recovery of zinc in the low spike standard matrix soil was calculated by subtracting the method blank value. This resulted in high variability in the control limits and spike recoveries for zinc. Based on a review of the weekly control charts, the USAEC Chemistry Branch felt the zinc sample results in the associated samples should be rejected. Based on further review of the complete data package, it was determined that the standard matrix recoveries did not impact the sample results. However, the low levels of zinc in the samples were considered to be estimated because of the variable control limits.

F.9 SEDIMENT SAMPLES

Percent solids results for sediment samples are provided on Table F-8. The data quality objective for sediments was to achieve greater than 30 percent solids. E & E employed sampling techniques described in the work plan to achieve this goal while maintaining the representativeness of the sample. Samples with low percent solids were evaluated based on site conditions to determine if re-sampling would have improved the levels of solids.

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
UB	TCL BNA	SMV1	Diethyl phthalate	DEP	0.66000	UGG
UB	TCL BNA	SMV1	Dimethyl phthalate	DMP	0.66000	UGG
UB	TCL BNA	SMV1	DI-n-butyl phthalate	DNBP	0.66000	UGG
UB	TCL BNA	SMV1	Di-n-octyl phthalate	DNOP	0.66000	UGG
UB	TCL BNA	SMV1	Fluoranthene	FANT	0.66000	UGG
UB	TCL BNA	SMV1	Fluorene	FLRENE	0.66000	UGG
UB	TCL BNA	SMV1	Hexachlorobutadiene	HCBD	0.66000	UGG
UB	TCL BNA	SMV1	Indeno(1,2,3-cd)pyrene	ICDPYR	0.66000	UGG
UB	TCL BNA	SMV1	Isophorone	ISOPHR	0.66000	UGG
UB	TCL BNA	SMV1	Naphthalene	NAP	0.66000	UGG
UB	TCL BNA	SMV1	Nitrobenzene	NB	0.66000	UGG
UB	TCL BNA	SMV1	N-nitrosodipropylamine	NNDNPA	0.66000	UGG
UB	TCL BNA	SMV1	N-nitrosodiphenylamine	NNDPA	0.66000	UGG
UB	TCL BNA	SMV1	Pentachlorophenol	PCP	0.66000	UGG
UB	TCL BNA	SMV1	Phenanthrene	PHANTR	0.66000	UGG
UB	TCL BNA	SMV1	Phenol	PHENOL	0.66000	UGG
UB	TCL BNA	SMV1	Pyrene	PYR	0.66000	UGG
UB	TCL Pest	PST1	alpha-BHC	ABHC	0.00200	UGG
UB	TCL Pest	PST1	alpha-Chlordane	ACLDAN	0.00200	UGG
UB	TCL Pest	PST1	Endosulfan, A	AENSLF	0.00200	UGG
UB	TCL Pest	PST1	Aldrin	ALDRN	0.00200	UGG
UB	TCL Pest	PST1	beta-BHC	BBHC	0.00200	UGG
UB	TCL Pest	PST1	Endosulfan,B	BENSLF	0.00200	UGG
UB	TCL Pest	PST1	delta-BHC	DBHC	0.00200	UGG
UB	TCL Pest	PST1	Dieldrin	DLDRN	0.00200	UGG
UB	TCL Pest	PST1	Endrin	ENDRN	0.00200	UGG
UB	TCL Pest	PST1	Endrin Aldehyde	ENDRNA	0.00200	UGG
UB	TCL Pest	PST1	Endosulfan Sulfate	ESFSO4	0.00200	UGG
UB	TCL Pest	PST1	gamma-Chlordane	GCLDAN	0.00200	UGG
UB	TCL Pest	PST1	Heptachlor	HPCL	0.00200	UGG
UB	TCL Pest	PST1	Heptachlor Epoxide	HPCLE	0.00200	UGG
UB	TCL Pest	PST1	Lindane	LIN	0.00200	UGG
UB	TCL Pest	PST1	Methoxychlor	MEXCLR	0.02000	UGG
UB	TCL Pest	PST1	PCB-1016	PCB016	0.02000	UGG
UB	TCL Pest	PST1	PCB-1221	PCB221	0.02000	UGG
UB	TCL Pest	PST1	PCB-1232	PCB232	0.02000	UGG
UB	TCL Pest	PST1	PCB-1242	PCB242	0.02000	UGG
UB	TCL Pest	PST1	PCB-1248	PCB248	0.02000	UGG
UB	TCL Pest	PST1	PCB-1254	PCB254	0.02000	UGG
UB	TCL Pest	PST1	PCB-1260	PCB260	0.02000	UGG
UB	TCL Pest	PST1	P,P-DDD	PPDDD	0.00200	UGG
UB	TCL Pest	PST1	P,P-DDE	PPDDE	0.00200	UGG
UB	TCL Pest	PST1	P,P-DDT	PPDDT	0.00200	UGG
UB	TCL Pest	PST1	Toxaphene	TXPHEN	0.10000	UGG
		ENSYS	PCB-1016	PCB016	4.00000	UGG
		ENSYS	PCB-1232	PCB232	4.00000	UGG
		ENSYS	PCB-1242	PCB242	2.00000	UGG
		ENSYS	PCB-1248	PCB248	1.00000	UGG
		ENSYS	PCB-1254	PCB254	0.40000	UGG
		ENSYS	PCB-1260	PCB260	0.40000	UGG

Table F-2 Method Blank Hits								
Test	Method	Lab	Lot	No	Analyte	Value	Units	FLAG
EXPLOSIVES	EXL1	EL	AATE	001	4-Amino-2,6-dinitrotoluene	0.30300	UGL	J
TAL METAL	ICP1	EL	AAOQ	001	Sodium	496.00000	UGL	J
TAL METAL	ICP1	EL	AAOQ	001	Zinc	6.28000	UGL	J
TAL METAL	ICP1	EL	AAVY	001	Aluminum	50.60000	UGL	
TAL METAL	ICP1	EL	AAVY	001	Zinc	3.34000	UGL	J
TAL METAL	ICP1	EL	AAVZ	001	Beryllium	0.12700	UGL	J
TAL METAL	ICP1	EL	AAVZ	001	Sodium	255.00000	UGL	J
TAL METAL	ICP1	EL	AAVZ	001	Zinc	8.02000	UGL	J
TAL METAL	ICP1	EL	AAWA	001	Aluminum	16.80000	UGL	J
TAL METAL	ICP1	EL	AAWA	001	Zinc	10.40000	UGL	J
TAL METAL	ICP1	EL	ABEL	001	Potassium	317.00000	UGL	J
TAL METAL	ICP1	EL	ABEL	001	Zinc	5.90000	UGL	J
TAL METAL	ICP1	EL	ABGT	001	Potassium	905.00000	UGL	J
TAL METAL	ICP1	EL	ABGT	001	Sodium	1190.00000	UGL	J
TAL METAL	GPB1	EL	ABHV	001	Lead	0.68000	UGL	J
TAL METAL	GPB1	EL	ABIC	001	Lead	0.79000	UGL	J
TCL BNA	SMV1	EL	AAKM	002	C35	0.18000	UGG	
TCL BNA	SMV1	EL	AAMN	001	Di-n-butyl-phthalate	0.08200	UGG	J
TCL BNA	SMV1	EL	AAMN	002	Di-n-butyl-phthalate	0.09200	UGG	J
TCL BNA	SMV1	EL	AANC	002	C36	0.12000	UGG	
TCL BNA	SMV1	EL	AAND	002	LINOLA	16.00000	UGL	
TCL BNA	SMV1	EL	AANO	001	LINOLA	0.12000	UGG	
TCL BNA	SMV1	EL	AANP	002	2,4,6-Tribromophenyl	0.96000	UGG	
TCL BNA	SMV1	EL	AANP	001	LINOLA	0.10000	UGG	
TCL BNA	SMV1	EL	AASH	001	Bis(2-ethylhexyl)phthalate	0.04700	UGG	J
TCL BNA	SMV1	EL	AASH	002	Bis(2-ethylhexyl)phthalate	0.05500	UGG	J
TCL BNA	SMV1	EL	AASH	001	Butyl benzyl phthalate	0.05900	UGG	J
TCL BNA	SMV1	EL	AASH	002	Butyl benzyl phthalate	0.07300	UGG	J
TCL BNA	SMV1	EL	AASH	001	Di-n-butyl-phthalate	0.20000	UGG	J
TCL BNA	SMV1	EL	AASH	002	Di-n-butyl-phthalate	0.16000	UGG	J
TCL BNA	SMV1	EL	AASI	001	Diethyl phthalate	0.06500	UGG	J
TCL BNA	SMV1	EL	AASI	002	Diethyl phthalate	0.05200	UGG	J
TCL BNA	SMV1	EL	AASP	001	LINOLA	0.29000	UGG	
TCL BNA	SMV1	EL	AASS	002	Di-n-butyl-phthalate	0.09700	UGG	J
TCL BNA	SMV1	EL	AASY	001	Bis(2-ethylhexyl)phthalate	0.21000	UGG	J
TCL BNA	SMV1	EL	AASZ	001	Bis(2-chloroisopropyl) ether	0.08600	UGG	J
TCL BNA	SMV1	EL	AASZ	002	Di-n-butyl-phthalate	0.06100	UGG	J
TCL BNA	SMV1	EL	AATO	001	Bis(2-ethylhexyl)phthalate	0.05000	UGG	J
TCL BNA	SMV1	EL	AATO	002	Bis(2-ethylhexyl)phthalate	0.08300	UGG	J
TCL BNA	SMV1	EL	AATO	002	Di-n-butyl-phthalate	0.03800	UGG	J
TCL BNA	SMV1	EL	AATR	002	C36	0.20000	UGG	
TCL BNA	SMV1	EL	AAYN	001	Bis(2-ethylhexyl)phthalate	0.05800	UGG	J
TCL BNA	SMV1	EL	AAYN	002	Bis(2-ethylhexyl)phthalate	0.05900	UGG	J

Table F-8

Percent Solids in Sediment

Site ID	Field Sample Number	Percent Solids	Sample Date
E3-A05-D01	DXA05011	31.7	09/20/93
E3-A06-D01	DXA06011	54.8	09/14/93
E3-A06-D02	DXA06021	75.6	09/14/93
E3-A10-D01	DX1001X1	16.5	08/10/93
E3-A10-D01	DXA10011	27.5	09/23/93
E3-A10-D02	DX1002X1	16.6	08/10/93
E3-A11-D01	DXA11011	73.7	09/15/93
E3-A11-D02	DXA11021	62.1	09/15/93
E3-BCK-D01	DXBCK011	77.7	09/15/93
E3-BCK-D02	DXBCK021	74.0	09/22/93
E3-BCK-D02	DDBCK021	73.8	09/22/93
E3-BCK-D03	DXBCK031	79.2	09/17/93
E3-BCK-D04	DXBCK041	84.7	09/17/93
E3-BCK-D05	DXBCK051	99.3	09/22/93
E3-BCK-D08	DXBCK081	80.4	09/21/93
E3-OFF-D01	DXOFA011	24.2	11/09/93
E3-OFF-D02	DXOFA021	21.3	11/09/93
E3-OFF-D03	DXOFA031	19.0	11/09/93
E3-OFF-D04	DXOFA041	34.2	11/09/93
E3-OFF-D05	DXOFA051	25.7	11/09/93
E3-OFF-D06	DXOFA061	15.8	11/09/93
E3-P11-D01	DX1101X1	66.8	08/03/93
E3-P11-D02	DX1102X1	47.9	08/03/93
E3-P11-D03	DXP11031	73.2	09/15/93
E3-P11-D04	DXP11042	19.3	12/02/93
E3-P11-D04	DX1104X2	48.9	04/26/94
E3-P13-D01	DX1301X1	14.5	08/02/93
E3-P13-D01	DD1301X1	47.9	08/02/93
E3-P13-D01	DXP13012	17.4	12/01/93
E3-P13-D02	DX1302X1	96.5	08/02/93
E3-P13-D02	DXP13022	91.2	12/01/93
E3-P13-D03	DX1303X1	86.8	08/03/93
E3-P13-D03	DXP13032	62.0	12/01/93
E3-P13-D04	DX1304X1	64.1	08/03/93
E3-P13-D04	DXP13042	71.9	12/01/93
E3-P13-D05	DX1305X1	71.4	08/03/93
E3-P13-D05	DXP13052	74.5	12/01/93
E3-P26-D01	DX2601X1	66.2	08/04/93
E3-P26-D01	DXP26012	9.5	12/02/93
E3-P26-D02	DX2602X1	74.6	08/04/93
E3-P26-D02	DXP25022	75.8	12/02/93
E3-P26-D03	DX2603X1	68.2	08/05/93
E3-P26-D03	DXP26032	56.5	12/02/93
E3-P26-D04	DX2604X1	69.4	08/05/93

Table F-8

Percent Solids in Sediment

Site ID	Field Sample Number	Percent Solids	Sample Date
E3-P26-D04	DXP26042	58.5	12/02/93
E3-P37-D01	DXP37011	20.3	09/16/93
E3-P37-D02	DXP37021	77.7	09/16/93
E3-P37-D03	DXP37031	34.5	09/23/93
E3-P39-D01	DX3901X1	18.4	08/11/93
E3-P39-D01	DD3901X1	20.1	08/11/93
E3-P39-D02	DX3902X1	23.8	08/11/93
E3-P39-D03	DX3903X1	22.1	08/11/93
E3-P39-D04	DX3904X1	22.5	08/11/93
E3-P39-D05	DX3905X1	21.2	08/11/93
E3-P39-D06	DX3906X1	22.8	08/11/93
E3-P42-D01	DX4201X1	67.0	08/03/93
E3-P45-D01	DXP45011	74.5	08/20/93
E3-P57-D01	DXP57011	37.4	09/16/93
E3-P58-D01	DXP58011	26.8	09/16/93
E3-P58-D02	DXP58021	95.5	09/16/93
E3-PUF-D01	DXPUF011	46.8	11/05/93
E3-PUF-D02	DXPUF021	11.5	11/05/93
E3-PUF-D02	DDPUF021	11.9	11/05/93
E3-PUF-D03	DXPUF031	8.4	11/05/93
E3-PUF-D04	DXPUF041	9.0	11/05/93
E3-PUF-D05	DXPUF051	17.2	11/05/93
E3-PUF-D06	DXPUF061	9.2	11/05/93

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
EL	EXPLOSIVES	EXL1	1,3,5-Trinitrobenzene	135TNB	1.00000	UGG
EL	EXPLOSIVES	EXL1	1,3-Dinitrobenzene	13DNB	1.00000	UGG
EL	EXPLOSIVES	EXL1	2,4,6-Trinitrotoluene	246TNT	1.00000	UGG
EL	EXPLOSIVES	EXL1	2,4-DNT	24DNT	1.00000	UGG
EL	EXPLOSIVES	EXL1	2,6-DNT	26DNT	1.00000	UGG
EL	EXPLOSIVES	EXL1	2-Amino-4,6-dinitrotoluene	2A46DT	1.00000	UGG
EL	EXPLOSIVES	EXL1	2-Nitrotoluene	2NT	1.00000	UGG
EL	EXPLOSIVES	EXL1	3-Nitrotoluene	3NT	1.00000	UGG
EL	EXPLOSIVES	EXL1	4-Amino-2,6-dinitrotoluene	4A26DT	1.00000	UGG
EL	EXPLOSIVES	EXL1	4-Nitrotoluene	4NT	1.00000	UGG
EL	EXPLOSIVES	EXL1	HMX	HMX	1.00000	UGG
EL	EXPLOSIVES	EXL1	Nitrobenzene	NB	1.00000	UGG
EL	EXPLOSIVES	EXL1	Cyclonite	RDX	1.00000	UGG
EL	EXPLOSIVES	EXL1	Tetryl, total	TETRYL	1.00000	UGG
EL	EXPLOSIVES	EXL2	Nitroglycerine	NG	10.00000	UGG
EL	EXPLOSIVES	EXL2	PETN	PETN	10.00000	UGG
EL	EXPLOSIVES	EXL1	1,3,5-Trinitrobenzene	135TNB	1.00000	UGL
EL	EXPLOSIVES	EXL1	1,3-Dinitrobenzene	13DNB	1.00000	UGL
EL	EXPLOSIVES	EXL1	2,4,6-Trinitrotoluene	246TNT	1.00000	UGL
EL	EXPLOSIVES	EXL1	2,4-DNT	24DNT	1.00000	UGL
EL	EXPLOSIVES	EXL1	2,6-DNT	26DNT	1.00000	UGL
EL	EXPLOSIVES	EXL1	2-Amino-4,6-dinitrotoluene	2A46DT	1.00000	UGL
EL	EXPLOSIVES	EXL1	2-Nitrotoluene	2NT	1.00000	UGL
EL	EXPLOSIVES	EXL1	3-Nitrotoluene	3NT	1.00000	UGL
EL	EXPLOSIVES	EXL1	4-Amino-2,6-dinitrotoluene	4A26DT	1.00000	UGL
EL	EXPLOSIVES	EXL1	4-Nitrotoluene	4NT	1.00000	UGL
EL	EXPLOSIVES	EXL1	HMX	HMX	1.00000	UGL
EL	EXPLOSIVES	EXL1	Nitrobenzene	NB	1.00000	UGL
EL	EXPLOSIVES	EXL1	Cyclonite	RDX	1.00000	UGL
EL	EXPLOSIVES	EXL1	Tetryl, total	TETRYL	1.00000	UGL
EL	EXPLOSIVES	EXL2	Nitroglycerine	NG	10.00000	UGL
EL	EXPLOSIVES	EXL2	PETN	PETN	10.00000	UGL
EL	TAL METAL	GAS1	Arsenic	AS	0.20000	UGG
EL	TAL METAL	GSB1	Antimony	SB	0.50000	UGG
EL	TAL METAL	GSE1	Selenium	SE	0.20000	UGG
EL	TAL METAL	GTL1	Thallium	TL	0.50000	UGG
EL	TAL METAL	HGC1	Mercury	HG	0.10000	UGG
EL	TAL METAL	ICP1	Silver	AG	0.20000	UGG
EL	TAL METAL	ICP1	Aluminum	AL	300.00000	UGG
EL	TAL METAL	ICP1	Barium	BA	5.00000	UGG
EL	TAL METAL	ICP1	Beryllium	BE	0.50000	UGG
EL	TAL METAL	ICP1	Calcium	CA	500.00000	UGG
EL	TAL METAL	ICP1	Cadmium	CD	0.50000	UGG
EL	TAL METAL	ICP1	Cobalt	CO	1.00000	UGG
EL	TAL METAL	ICP1	Chromium	CR	2.00000	UGG
EL	TAL METAL	ICP1	Iron	FE	350.00000	UGG
EL	TAL METAL	ICP1	Potassium	K	200.00000	UGG
EL	TAL METAL	ICP1	Magnesium	MG	500.00000	UGG
EL	TAL METAL	ICP1	Sodium	NA	200.00000	UGG

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
EL	TAL METAL	ICP1	Nickel	NI	1.00000	UGG
EL	TAL METAL	ICP1	Zinc	ZN	2.00000	UGG
EL	TAL METAL	GAS1	Arsenic	AS	2.00000	UGL
EL	TAL METAL	GPB1	Lead	PB	5.00000	UGL
EL	TAL METAL	GSB1	Antimony	SB	5.00000	UGL
EL	TAL METAL	GSE1	Selenium	SE	2.00000	UGL
EL	TAL METAL	GTL1	Thallium	TL	2.00000	UGL
EL	TAL METAL	HGC1	Mercury	HG	0.20000	UGL
EL	TAL METAL	ICP1	Silver	AG	2.00000	UGL
EL	TAL METAL	ICP1	Aluminum	AL	25.00000	UGL
EL	TAL METAL	ICP1	Barium	BA	10.00000	UGL
EL	TAL METAL	ICP1	Beryllium	BE	5.00000	UGL
EL	TAL METAL	ICP1	Calcium	CA	500.00000	UGL
EL	TAL METAL	ICP1	Cadmium	CD	5.00000	UGL
EL	TAL METAL	ICP1	Cobalt	CO	10.00000	UGL
EL	TAL METAL	ICP1	Chromium	CR	10.00000	UGL
EL	TAL METAL	ICP1	Copper	CU	10.00000	UGL
EL	TAL METAL	ICP1	Iron	FE	25.00000	UGL
EL	TAL METAL	ICP1	Potassium	K	1000.00000	UGL
EL	TAL METAL	ICP1	Magnesium	MG	500.00000	UGL
EL	TAL METAL	ICP1	Manganese	MN	5.00000	UGL
EL	TAL METAL	ICP1	Sodium	NA	2000.00000	UGL
EL	TAL METAL	ICP1	Nickel	NI	10.00000	UGL
EL	TAL METAL	ICP1	Vanadium	V	10.00000	UGL
EL	TAL METAL	ICP1	Zinc	ZN	20.00000	UGL
EL	TCL BNA	SMV1	1,2,4-Trichlorobenzene	124TCB	0.33000	UGG
EL	TCL BNA	SMV1	1,2-Dichlorobenzene	12DCLB	0.33000	UGG
EL	TCL BNA	SMV1	1,3-Dichlorobenzene	13DCLB	0.33000	UGG
EL	TCL BNA	SMV1	1,4-Dichlorobenzene	14DCLB	0.33000	UGG
EL	TCL BNA	SMV1	2,4,5-Trichlorophenol	245TCP	0.33000	UGG
EL	TCL BNA	SMV1	2,4,6-Trichlorophenol	246TCP	0.33000	UGG
EL	TCL BNA	SMV1	2,4-Dichlorophenol	24DCLP	0.33000	UGG
EL	TCL BNA	SMV1	2,4-Dimethylphenol	24DMPN	0.33000	UGG
EL	TCL BNA	SMV1	2,4-Dinitrophenol	24DNP	0.33000	UGG
EL	TCL BNA	SMV1	2,4-DNT	24DNT	0.33000	UGG
EL	TCL BNA	SMV1	2,6-DNT	26DNT	0.33000	UGG
EL	TCL BNA	SMV1	2-Chlorophenol	2CLP	0.33000	UGG
EL	TCL BNA	SMV1	2-Chloronaphthalene	2CNAP	0.33000	UGG
EL	TCL BNA	SMV1	2-Methylnaphthalene	2MNAP	0.33000	UGG
EL	TCL BNA	SMV1	2-Methyl phenol	2MP	0.33000	UGG
EL	TCL BNA	SMV1	2-Nitroaniline	2NANIL	0.66000	UGG
EL	TCL BNA	SMV1	2-Nitrophenol	2NP	0.33000	UGG
EL	TCL BNA	SMV1	3,3'-Dichlorobenzidine	33DCBD	0.66000	UGG
EL	TCL BNA	SMV1	3-Nitroaniline	3NANIL	0.66000	UGG
EL	TCL BNA	SMV1	4,6-Dinitro-2-methylphenol	46DN2C	0.33000	UGG
EL	TCL BNA	SMV1	4-Bromophenyl phenyl ether	4BRPPE	0.33000	UGG
EL	TCL BNA	SMV1	4-Chloroaniline	4CANIL	0.33000	UGG
EL	TCL BNA	SMV1	4-Chloro-3-methylphenol	4CL3C	0.33000	UGG
EL	TCL BNA	SMV1	4-Chlorophenyl phenyl ether	4CLPPE	0.33000	UGG
EL	TCL BNA	SMV1	4-Methyl phenol	4MP	0.33000	UGG

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
EL	TCL BNA	SMV1	4-Nitroaniline	4NANIL	0.66000	UGG
EL	TCL BNA	SMV1	4-Nitrophenol	4NP	0.66000	UGG
EL	TCL BNA	SMV1	Acenaphthene	ANAPNE	0.33000	UGG
EL	TCL BNA	SMV1	Acenaphthylene	ANAPYL	0.33000	UGG
EL	TCL BNA	SMV1	Anthracene	ANTRC	0.33000	UGG
EL	TCL BNA	SMV1	Bis (2-chloroethoxy) methane	B2CEXM	0.33000	UGG
EL	TCL BNA	SMV1	Bis(2-chloroisopropyl) ether	B2CIPE	0.33000	UGG
EL	TCL BNA	SMV1	Bis(2-chloroethyl)ether	B2CLEE	0.33000	UGG
EL	TCL BNA	SMV1	Bis(2-ethylhexyl)phthalate	B2EHP	0.33000	UGG
EL	TCL BNA	SMV1	Benzo(a)anthracene	BAANTR	0.33000	UGG
EL	TCL BNA	SMV1	Benzo(a)pyrene	BAPYR	0.33000	UGG
EL	TCL BNA	SMV1	Benzo(b)fluoranthene	BBFANT	0.33000	UGG
EL	TCL BNA	SMV1	Butyl benzyl phthalate	BBZP	0.33000	UGG
EL	TCL BNA	SMV1	Benzo(ghi)perylene	BGHIPY	0.33000	UGG
EL	TCL BNA	SMV1	Benzo(k)fluoranthene	BKFANT	0.33000	UGG
EL	TCL BNA	SMV1	Chrysene	CHRY	0.33000	UGG
EL	TCL BNA	SMV1	Hexachlorobenzene	CL6BZ	0.33000	UGG
EL	TCL BNA	SMV1	Hexachlorocyclopentadiene	CL6CP	0.33000	UGG
EL	TCL BNA	SMV1	Hexachloroethane	CL6ET	0.33000	UGG
EL	TCL BNA	SMV1	Dibenzo(a,h)anthracene	DBAHA	0.33000	UGG
EL	TCL BNA	SMV1	Dibenzofuran	DBZFUR	0.33000	UGG
EL	TCL BNA	SMV1	Diethyl phthalate	DEP	0.33000	UGG
EL	TCL BNA	SMV1	Dimethyl phthalate	DMP	0.33000	UGG
EL	TCL BNA	SMV1	Di-n-butyl-phthalate	DNBP	0.33000	UGG
EL	TCL BNA	SMV1	Di-n-octyl phthalate	DNOP	0.33000	UGG
EL	TCL BNA	SMV1	Fluoranthene	FANT	0.33000	UGG
EL	TCL BNA	SMV1	Fluorene	FLRENE	0.33000	UGG
EL	TCL BNA	SMV1	Hexachlorobutadiene	HCBD	0.33000	UGG
EL	TCL BNA	SMV1	Indeno(1,2,3-cd)pyrene	ICDPYR	0.33000	UGG
EL	TCL BNA	SMV1	Isophorone	ISOPHR	0.33000	UGG
EL	TCL BNA	SMV1	Naphthalene	NAP	0.33000	UGG
EL	TCL BNA	SMV1	Nitrobenzene	NB	0.33000	UGG
EL	TCL BNA	SMV1	N-nitrosodipropylamine	NNDNPA	0.33000	UGG
EL	TCL BNA	SMV1	N-nitrosodiphenylamine	NNDPA	0.33000	UGG
EL	TCL BNA	SMV1	Pentachlorophenol	PCP	0.66000	UGG
EL	TCL BNA	SMV1	Phenanthrene	PHANTR	0.33000	UGG
EL	TCL BNA	SMV1	Phenol	PHENOL	0.33000	UGG
EL	TCL BNA	SMV1	Pyrene	PYR	0.33000	UGG
EL	TCL BNA	SMV1	1,2,4-Trichlorobenzene	124TCB	10.00000	UGL
EL	TCL BNA	SMV1	1,2-Dichlorobenzene	12DCLB	10.00000	UGL
EL	TCL BNA	SMV1	1,3-Dichlorobenzene	13DCLB	10.00000	UGL
EL	TCL BNA	SMV1	1,4-Dichlorobenzene	14DCLB	10.00000	UGL
EL	TCL BNA	SMV1	2,4,5-Trichlorophenol	245TCP	20.00000	UGL
EL	TCL BNA	SMV1	2,4,6-Trichlorophenol	246TCP	20.00000	UGL
EL	TCL BNA	SMV1	2,4-Dichlorophenol	24DCLP	10.00000	UGL
EL	TCL BNA	SMV1	2,4-Dimethylphenol	24DMPN	20.00000	UGL
EL	TCL BNA	SMV1	2,4-Dinitrophenol	24DNP	20.00000	UGL
EL	TCL BNA	SMV1	2,4-DNT	24DNT	10.00000	UGL
EL	TCL BNA	SMV1	2,6-DNT	26DNT	10.00000	UGL
EL	TCL BNA	SMV1	2-Chlorophenol	2CLP	10.00000	UGL
EL	TCL BNA	SMV1	2-Chloronaphthalene	2CNAP	10.00000	UGL

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
EL	TCL BNA	SMV1	2-Methylnaphthalene	2MNAP	10.00000	UGL
EL	TCL BNA	SMV1	2-Methyl phenol	2MP	20.00000	UGL
EL	TCL BNA	SMV1	2-Nitroaniline	2NANIL	20.00000	UGL
EL	TCL BNA	SMV1	2-Nitrophenol	2NP	10.00000	UGL
EL	TCL BNA	SMV1	3,3'-Dichlorobenzidine	33DCBD	20.00000	UGL
EL	TCL BNA	SMV1	3-Nitroaniline	3NANIL	20.00000	UGL
EL	TCL BNA	SMV1	4,6-Dinitro-2-methylphenol	46DN2C	20.00000	UGL
EL	TCL BNA	SMV1	4-Bromophenyl phenyl ether	4BRPPE	10.00000	UGL
EL	TCL BNA	SMV1	4-Chloroaniline	4CANIL	20.00000	UGL
EL	TCL BNA	SMV1	4-Chloro-3-methylphenol	4CL3C	10.00000	UGL
EL	TCL BNA	SMV1	4-Chlorophenyl phenyl ether	4CLPPE	10.00000	UGL
EL	TCL BNA	SMV1	4-Methyl phenol	4MP	10.00000	UGL
EL	TCL BNA	SMV1	4-Nitroaniline	4NANIL	20.00000	UGL
EL	TCL BNA	SMV1	4-Nitrophenol	4NP	20.00000	UGL
EL	TCL BNA	SMV1	Acenaphthene	ANAPNE	10.00000	UGL
EL	TCL BNA	SMV1	Acenaphthylene	ANAPYL	10.00000	UGL
EL	TCL BNA	SMV1	Anthracene	ANTRC	10.00000	UGL
EL	TCL BNA	SMV1	Bis (2-chloroethoxy) methane	B2CEXM	10.00000	UGL
EL	TCL BNA	SMV1	Bis(2-chloroisopropyl) ether	B2CIPE	10.00000	UGL
EL	TCL BNA	SMV1	Bis(2-chloroethyl)ether	B2CLEE	10.00000	UGL
EL	TCL BNA	SMV1	Bis(2-ethylhexyl)phthalate	B2EHP	10.00000	UGL
EL	TCL BNA	SMV1	Benzo(a)anthracene	BAANTR	10.00000	UGL
EL	TCL BNA	SMV1	Benzo(a)pyrene	BAPYR	10.00000	UGL
EL	TCL BNA	SMV1	Benzo(b)fluoranthene	BBFANT	10.00000	UGL
EL	TCL BNA	SMV1	Butyl benzyl phthalate	BBZP	10.00000	UGL
EL	TCL BNA	SMV1	Benzo(ghi)perylene	BGHIPY	10.00000	UGL
EL	TCL BNA	SMV1	Benzo(k)fluoranthene	BKFANT	10.00000	UGL
EL	TCL BNA	SMV1	Chrysene	CHRY	10.00000	UGL
EL	TCL BNA	SMV1	Hexachlorobenzene	CL6BZ	10.00000	UGL
EL	TCL BNA	SMV1	Hexachlorocyclopentadiene	CL6CP	10.00000	UGL
EL	TCL BNA	SMV1	Hexachloroethane	CL6ET	10.00000	UGL
EL	TCL BNA	SMV1	Dibenzo(a,h)anthracene	DBAHA	10.00000	UGL
EL	TCL BNA	SMV1	Dibenzofuran	DBZFUR	20.00000	UGL
EL	TCL BNA	SMV1	Diethyl phthalate	DEP	10.00000	UGL
EL	TCL BNA	SMV1	Dimethyl phthalate	DMP	10.00000	UGL
EL	TCL BNA	SMV1	Di-n-butyl-phthalate	DNBP	10.00000	UGL
EL	TCL BNA	SMV1	Di-n-octyl phthalate	DNOP	10.00000	UGL
EL	TCL BNA	SMV1	Fluoranthene	FANT	10.00000	UGL
EL	TCL BNA	SMV1	Fluorene	FLRENE	10.00000	UGL
EL	TCL BNA	SMV1	Hexachlorobutadiene	HCBD	10.00000	UGL
EL	TCL BNA	SMV1	Indeno(1,2,3-cd)pyrene	ICDPYR	10.00000	UGL
EL	TCL BNA	SMV1	Isophorone	ISOPHR	10.00000	UGL
EL	TCL BNA	SMV1	Naphthalene	NAP	10.00000	UGL
EL	TCL BNA	SMV1	Nitrobenzene	NB	10.00000	UGL
EL	TCL BNA	SMV1	N-nitrosodipropylamine	NNDNPA	10.00000	UGL
EL	TCL BNA	SMV1	N-nitrosodiphenylamine	NNDPA	10.00000	UGL
EL	TCL BNA	SMV1	Pentachlorophenol	PCP	20.00000	UGL
EL	TCL BNA	SMV1	Phenanthrene	PHANTR	10.00000	UGL
EL	TCL BNA	SMV1	Phenol	PHENOL	10.00000	UGL
EL	TCL BNA	SMV1	Pyrene	PYR	10.00000	UGL
EL	TCL Pest	PST1	alpha-BHC	ABHC	0.00100	UGG

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
EL	TCL Pest	PST1	Endosulfan,A	AENSLF	0.00100	UGG
EL	TCL Pest	PST1	Aldrin	ALDRN	0.00100	UGG
EL	TCL Pest	PST1	beta-BHC	BBHC	0.00100	UGG
EL	TCL Pest	PST1	Endosulfan,B	BENSLF	0.00200	UGG
EL	TCL Pest	PST1	Chlordane	CLDAN	0.00800	UGG
EL	TCL Pest	PST1	delta-BHC	DBHC	0.00100	UGG
EL	TCL Pest	PST1	Dieldrin	DLDRN	0.00200	UGG
EL	TCL Pest	PST1	Endrin	ENDRN	0.00200	UGG
EL	TCL Pest	PST1	Endrin Aldehyde	ENDRNA	0.00200	UGG
EL	TCL Pest	PST1	Endosulfan Sulfate	ESFSO4	0.00200	UGG
EL	TCL Pest	PST1	Heptachlor	HPCL	0.00100	UGG
EL	TCL Pest	PST1	Heptachlor Epoxide	HPCLE	0.00100	UGG
EL	TCL Pest	PST1	Lindane	LIN	0.00100	UGG
EL	TCL Pest	PST1	Methoxychlor	MEXCLR	0.00800	UGG
EL	TCL Pest	PST1	PCB-1016	PCB016	0.02000	UGG
EL	TCL Pest	PST1	PCB-1221	PCB221	0.03300	UGG
EL	TCL Pest	PST1	PCB-1232	PCB232	0.02000	UGG
EL	TCL Pest	PST1	PCB-1242	PCB242	0.02000	UGG
EL	TCL Pest	PST1	PCB-1248	PCB248	0.02000	UGG
EL	TCL Pest	PST1	PCB-1254	PCB254	0.02000	UGG
EL	TCL Pest	PST1	PCB-1260	PCB260	0.02000	UGG
EL	TCL Pest	PST1	P,P-DDD	PPDDD	0.00200	UGG
EL	TCL Pest	PST1	P,P-DDE	PPDDE	0.00200	UGG
EL	TCL Pest	PST1	P,P-DDT	PPDDT	0.00200	UGG
EL	TCL Pest	PST1	Toxaphene	TXPHEN	0.03300	UGG
EL	TCL Pest	PST1	alpha-BHC	ABHC	0.02000	UGL
EL	TCL Pest	PST1	Endosulfan,A	AENSLF	0.02000	UGL
EL	TCL Pest	PST1	Aldrin	ALDRN	0.02000	UGL
EL	TCL Pest	PST1	beta-BHC	BBHC	0.02000	UGL
EL	TCL Pest	PST1	Endosulfan,B	BENSLF	0.04000	UGL
EL	TCL Pest	PST1	Chlordane	CLDAN	0.10000	UGL
EL	TCL Pest	PST1	delta-BHC	DBHC	0.02000	UGL
EL	TCL Pest	PST1	Dieldrin	DLDRN	0.04000	UGL
EL	TCL Pest	PST1	Endrin	ENDRN	0.04000	UGL
EL	TCL Pest	PST1	Endrin Aldehyde	ENDRNA	0.10000	UGL
EL	TCL Pest	PST1	Endosulfan Sulfate	ESFSO4	0.04000	UGL
EL	TCL Pest	PST1	Heptachlor	HPCL	0.02000	UGL
EL	TCL Pest	PST1	Heptachlor Epoxide	HPCLE	0.02000	UGL
EL	TCL Pest	PST1	Lindane	LIN	0.02000	UGL
EL	TCL Pest	PST1	Methoxychlor	MEXCLR	0.20000	UGL
EL	TCL Pest	PST1	PCB-1016	PCB016	0.50000	UGL
EL	TCL Pest	PST1	PCB-1221	PCB221	1.00000	UGL
EL	TCL Pest	PST1	PCB-1232	PCB232	0.50000	UGL
EL	TCL Pest	PST1	PCB-1242	PCB242	0.50000	UGL
EL	TCL Pest	PST1	PCB-1248	PCB248	0.50000	UGL
EL	TCL Pest	PST1	PCB-1254	PCB254	0.50000	UGL
EL	TCL Pest	PST1	PCB-1260	PCB260	0.50000	UGL
EL	TCL Pest	PST1	P,P-DDD	PPDDD	0.04000	UGL
EL	TCL Pest	PST1	P,P-DDE	PPDDE	0.04000	UGL
EL	TCL Pest	PST1	P,P-DDT	PPDDT	0.04000	UGL
EL	TCL Pest	PST1	Toxaphene	TXPHEN	1.00000	UGL

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
EL	TCL VOA	VMS1	1,1,1-Trichloroethane	111TCE	0.00500	UGG
EL	TCL VOA	VMS1	1,1,2-Trichloroethane	112TCE	0.00500	UGG
EL	TCL VOA	VMS1	1,1-Dichloroethene	11DCE	0.00500	UGG
EL	TCL VOA	VMS1	1,1-Dichloroethane	11DCLE	0.00500	UGG
EL	TCL VOA	VMS1	1,2-Dichloroethane	12DCLE	0.00500	UGG
EL	TCL VOA	VMS1	1,2-Dichloropropane	12DCLP	0.00500	UGG
EL	TCL VOA	VMS1	12DMB	12DMB	0.00500	UGG
EL	TCL VOA	VMS1	134DMB	134DMB	0.00500	UGG
EL	TCL VOA	VMS1	Acetone	ACET	0.10000	UGG
EL	TCL VOA	VMS1	Bromodichloromethane	BRDCLM	0.00500	UGG
EL	TCL VOA	VMS1	C12DCE	C12DCE	0.00500	UGG
EL	TCL VOA	VMS1	cis-1,3-dichloropropene	C13DCP	0.00500	UGG
EL	TCL VOA	VMS1	Vinyl Chloride	C2H3CL	0.01000	UGG
EL	TCL VOA	VMS1	Chloroethane	C2H5CL	0.01000	UGG
EL	TCL VOA	VMS1	Benzene	C6H6	0.00500	UGG
EL	TCL VOA	VMS1	Carbon tetrachloride	CCL4	0.00500	UGG
EL	TCL VOA	VMS1	Methylene chloride	CH2CL2	0.01000	UGG
EL	TCL VOA	VMS1	Bromomethane	CH3BR	0.01000	UGG
EL	TCL VOA	VMS1	Chloromethane	CH3CL	0.01000	UGG
EL	TCL VOA	VMS1	Bromoform	CHBR3	0.00500	UGG
EL	TCL VOA	VMS1	Chloroform	CHCL3	0.00500	UGG
EL	TCL VOA	VMS1	Chlorobenzene	CLC6H5	0.00500	UGG
EL	TCL VOA	VMS1	Carbon disulfide	CS2	0.00500	UGG
EL	TCL VOA	VMS1	Dibromochloromethane	DBRCLM	0.00500	UGG
EL	TCL VOA	VMS1	Ethylbenzene	ETC6H5	0.00500	UGG
EL	TCL VOA	VMS1	Toluene	MEC6H5	0.00500	UGG
EL	TCL VOA	VMS1	2-Butanone	MEK	0.01000	UGG
EL	TCL VOA	VMS1	Methylisobutyl ketone	MIBK	0.01000	UGG
EL	TCL VOA	VMS1	2-Hexanone	MNBK	0.01000	UGG
EL	TCL VOA	VMS1	Styrene	STYR	0.00500	UGG
EL	TCL VOA	VMS1	T12DCE	T12DCE	0.00500	UGG
EL	TCL VOA	VMS1	trans-1,3-dichloropropene	T13DCP	0.00500	UGG
EL	TCL VOA	VMS1	1,1,2,2-Tetrachloroethane	TCLEA	0.00500	UGG
EL	TCL VOA	VMS1	Tetrachloroethene	TCLEE	0.00500	UGG
EL	TCL VOA	VMS1	Trichloroethene	TRCLE	0.00500	UGG
EL	TCL VOA	VMS1	1,1,1-Trichloroethane	111TCE	5.00000	UGL
EL	TCL VOA	VMS1	1,1,2-Trichloroethane	112TCE	5.00000	UGL
EL	TCL VOA	VMS1	1,1-Dichloroethene	11DCE	5.00000	UGL
EL	TCL VOA	VMS1	1,1-Dichloroethane	11DCLE	5.00000	UGL
EL	TCL VOA	VMS1	1,2-Dichloroethane	12DCLE	5.00000	UGL
EL	TCL VOA	VMS1	1,2-Dichloropropane	12DCLP	5.00000	UGL
EL	TCL VOA	VMS1	12DMB	12DMB	5.00000	UGL
EL	TCL VOA	VMS1	134DMB	134DMB	10.00000	UGL
EL	TCL VOA	VMS1	Acetone	ACET	10.00000	UGL
EL	TCL VOA	VMS1	Bromodichloromethane	BRDCLM	5.00000	UGL
EL	TCL VOA	VMS1	C12DCE	C12DCE	5.00000	UGL
EL	TCL VOA	VMS1	cis-1,3-dichloropropene	C13DCP	5.00000	UGL
EL	TCL VOA	VMS1	Vinyl Chloride	C2H3CL	10.00000	UGL
EL	TCL VOA	VMS1	Chloroethane	C2H5CL	10.00000	UGL
EL	TCL VOA	VMS1	Benzene	C6H6	5.00000	UGL

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
EL	TCL VOA	VMS1	Carbon tetrachloride	CCL4	5.00000	UGL
EL	TCL VOA	VMS1	Methylene chloride	CH2CL2	5.00000	UGL
EL	TCL VOA	VMS1	Bromomethane	CH3BR	10.00000	UGL
EL	TCL VOA	VMS1	Chloromethane	CH3CL	10.00000	UGL
EL	TCL VOA	VMS1	Bromoform	CHBR3	5.00000	UGL
EL	TCL VOA	VMS1	Chloroform	CHCL3	5.00000	UGL
EL	TCL VOA	VMS1	Chlorobenzene	CLC6H5	5.00000	UGL
EL	TCL VOA	VMS1	Carbon disulfide	CS2	5.00000	UGL
EL	TCL VOA	VMS1	Dibromochloromethane	DBRCLM	5.00000	UGL
EL	TCL VOA	VMS1	Ethylbenzene	ETC6H5	5.00000	UGL
EL	TCL VOA	VMS1	Toluene	MEC6H5	5.00000	UGL
EL	TCL VOA	VMS1	2-Butanone	MEK	10.00000	UGL
EL	TCL VOA	VMS1	Methylisobutyl ketone	MIBK	10.00000	UGL
EL	TCL VOA	VMS1	2-Hexanone	MNBK	10.00000	UGL
EL	TCL VOA	VMS1	Styrene	STYR	5.00000	UGL
EL	TCL VOA	VMS1	T12DCE	T12DCE	5.00000	UGL
EL	TCL VOA	VMS1	trans-1,3-dichloropropene	T13DCP	5.00000	UGL
EL	TCL VOA	VMS1	1,1,2,2-Tetrachloroethane	TCLEA	5.00000	UGL
EL	TCL VOA	VMS1	Tetrachloroethene	TCLEE	5.00000	UGL
EL	TCL VOA	VMS1	Trichloroethene	TRCLE	5.00000	UGL
EL	TOC	00	Total Organic Carbon	TOC	1.00000	UGG
EL	TPHC	TPH1	Total Petroleum Hydrocarbons	TPHC	20.00000	UGG
EL	WQP	3652	Phosphorus, Total	P4	10.00000	UGL
EL	WQP	ANI1	Nitrite	NO2	100.00000	UGL
EL	WQP	ANI1	Nitrate	NO3	.100.00000	UGL
EL	WQP	ANI2	Nitrite	NO2	100.00000	UGL
EL	WQP	ANI2	Nitrate	NO3	100.00000	UGL
EL	WQP	ANI2	Orthophosphate	PO4ORT	200.00000	UGL
ES	LH11	LH11	245T	245T	0.00600	UGG
ES	LH11	LH11	245TP	245TP	0.00800	UGG
ES	LH11	LH11	24D	24D	0.01800	UGG
ES	LN05	LN05	ATZ	ATZ	0.25000	UGG
ES	LN05	LN05	CPYR	CPYR	0.05000	UGG
ES	LN05	LN05	DDVP	DDVP	0.45200	UGG
ES	LN05	LN05	DIAZ	DIAZ	32.80000	UGG
ES	LN05	LN05	MLTHN	MLTHN	0.58000	UGG
ES	LN05	LN05	MPRTHN	MPRTHN	32.70000	UGG
ES	LN05	LN05	PRTHN	PRTHN	0.73300	UGG
ES	LN05	LN05	RON	RON	0.05000	UGG
ES	LN05	LN05	SUPONA	SUPONA	0.25000	UGG
ES	UH14	UH14	245T	245T	0.07500	UGL
ES	UH14	UH14	245TP	245TP	0.17000	UGL
ES	UH14	UH14	24D	24D	0.80200	UGL
ES	UN07	UN07	ATZ	ATZ	0.51200	UGL
ES	UN07	UN07	CPYR	CPYR	0.32000	UGL
ES	UN07	UN07	DDVP	DDVP	0.25000	UGL
ES	UN07	UN07	DIAZ	DIAZ	0.31000	UGL
ES	UN07	UN07	MLTHN	MLTHN	0.25000	UGL

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
ES	UN07	UN07	MPRTHN	MPRTHN	0.30600	UGL
ES	UN07	UN07	PRTHN	PRTHN	0.25000	UGL
ES	UN07	UN07	RON	RON	0.30700	UGL
ES	UN07	UN07	SUPONA	SUPONA	0.23500	UGL
UB	TCL BNA	SMV1	1,2,4-Trichlorobenzene	124TCB	0.66000	UGG
UB	TCL BNA	SMV1	1,2-Dichlorobenzene	12DCLB	0.66000	UGG
UB	TCL BNA	SMV1	1,3-Dichlorobenzene	13DCLB	0.66000	UGG
UB	TCL BNA	SMV1	1,4-Dichlorobenzene	14DCLB	0.66000	UGG
UB	TCL BNA	SMV1	2,4,5-Trichlorophenol	245TCP	0.66000	UGG
UB	TCL BNA	SMV1	2,4,6-Trichlorophenol	246TCP	0.66000	UGG
UB	TCL BNA	SMV1	2,4-Dichlorophenol	24DCLP	0.66000	UGG
UB	TCL BNA	SMV1	2,4-Dimethylphenol	24DMPN	0.66000	UGG
UB	TCL BNA	SMV1	2,4-Dinitrophenol	24DNP	0.66000	UGG
UB	TCL BNA	SMV1	2,4-DNT	24DNT	0.66000	UGG
UB	TCL BNA	SMV1	2,6-DNT	26DNT	0.66000	UGG
UB	TCL BNA	SMV1	2-Chlorophenol	2CLP	0.66000	UGG
UB	TCL BNA	SMV1	2-Chloronaphthalene	2CNAP	0.66000	UGG
UB	TCL BNA	SMV1	2-Methylnaphthalene	2MNAP	0.66000	UGG
UB	TCL BNA	SMV1	2-Methyl phenol	2MP	0.66000	UGG
UB	TCL BNA	SMV1	2-Nitroaniline	2NANIL	1.70000	UGG
UB	TCL BNA	SMV1	2-Nitrophenol	2NP	1.70000	UGG
UB	TCL BNA	SMV1	3,3'-Dichlorobenzidine	33DCBD	0.66000	UGG
UB	TCL BNA	SMV1	3-Nitroaniline	3NANIL	1.70000	UGG
UB	TCL BNA	SMV1	4,6-Dinitro-2-methylphenol	46DN2C	1.70000	UGG
UB	TCL BNA	SMV1	4-Bromophenyl phenyl ether	4BRPPE	0.66000	UGG
UB	TCL BNA	SMV1	4-Chloroaniline	4CANIL	0.66000	UGG
UB	TCL BNA	SMV1	4-Chloro-3-methylphenol	4CL3C	0.66000	UGG
UB	TCL BNA	SMV1	4-Chlorophenyl phenyl ether	4CLPPE	0.66000	UGG
UB	TCL BNA	SMV1	4-Methyl phenol	4MP	0.66000	UGG
UB	TCL BNA	SMV1	4-Nitroaniline	4NANIL	1.70000	UGG
UB	TCL BNA	SMV1	4-Nitrophenol	4NP	1.70000	UGG
UB	TCL BNA	SMV1	Acenaphthene	ANAPNE	0.66000	UGG
UB	TCL BNA	SMV1	Acenaphthylene	ANAPYL	0.66000	UGG
UB	TCL BNA	SMV1	Anthracene	ANTRC	0.66000	UGG
UB	TCL BNA	SMV1	Bis (2-chloroethoxy) methane	B2CEXM	0.66000	UGG
UB	TCL BNA	SMV1	Bis(2-chloroethyl)ether	B2CLEE	0.66000	UGG
UB	TCL BNA	SMV1	Bis(2-ethylhexyl)phthalate	B2EHP	0.66000	UGG
UB	TCL BNA	SMV1	Benzo(a)anthracene	BAANTR	0.66000	UGG
UB	TCL BNA	SMV1	Benzo(a)pyrene	BAPYR	0.66000	UGG
UB	TCL BNA	SMV1	Benzo(b)fluoranthene	BBFANT	0.66000	UGG
UB	TCL BNA	SMV1	Butyl benzyl phthalate	BBZP	0.66000	UGG
UB	TCL BNA	SMV1	Benzoic acid	BENZOA	1.70000	UGG
UB	TCL BNA	SMV1	Benzo(ghi)perylene	BGHIPY	0.66000	UGG
UB	TCL BNA	SMV1	Benzo(k)fluoranthene	BKFANT	0.66000	UGG
UB	TCL BNA	SMV1	Benzyl Alcohol	BZALC	0.66000	UGG
UB	TCL BNA	SMV1	Chrysene	CHRY	0.66000	UGG
UB	TCL BNA	SMV1	Hexachlorobenzene	CL6BZ	0.66000	UGG
UB	TCL BNA	SMV1	Hexachlorocyclopentadiene	CL6CP	0.66000	UGG
UB	TCL BNA	SMV1	Hexachloroethane	CL6ET	0.66000	UGG
UB	TCL BNA	SMV1	Dibenzo(a,h)anthracene	DBAHA	0.66000	UGG
UB	TCL BNA	SMV1	Dibenzofuran	DBZFUR	0.66000	UGG

Table F-1

Method Reporting Limits

Lab	Test	Method	Analyte	Test nm	Value	Units
UB	TCL BNA	SMV1	Diethyl phthalate	DEP	0.66000	UGG
UB	TCL BNA	SMV1	Dimethyl phthalate	DMP	0.66000	UGG
UB	TCL BNA	SMV1	Di-n-butyl-phthalate	DNBP	0.66000	UGG
UB	TCL BNA	SMV1	Di-n-octyl phthalate	DNOP	0.66000	UGG
UB	TCL BNA	SMV1	Fluoranthene	FANT	0.66000	UGG
UB	TCL BNA	SMV1	Fluorene	FLRENE	0.66000	UGG
UB	TCL BNA	SMV1	Hexachlorobutadiene	HCBD	0.66000	UGG
UB	TCL BNA	SMV1	Indeno(1,2,3-cd)pyrene	ICDPYR	0.66000	UGG
UB	TCL BNA	SMV1	Isophorone	ISOPHR	0.66000	UGG
UB	TCL BNA	SMV1	Naphthalene	NAP	0.66000	UGG
UB	TCL BNA	SMV1	Nitrobenzene	NB	0.66000	UGG
UB	TCL BNA	SMV1	N-nitrosodipropylamine	NNDNPA	0.66000	UGG
UB	TCL BNA	SMV1	N-nitrosodiphenylamine	NNDPA	0.66000	UGG
UB	TCL BNA	SMV1	Pentachlorophenol	PCP	0.66000	UGG
UB	TCL BNA	SMV1	Phenanthrene	PHANTR	0.66000	UGG
UB	TCL BNA	SMV1	Phenol	PHENOL	0.66000	UGG
UB	TCL BNA	SMV1	Pyrene	PYR	0.66000	UGG
UB	TCL Pest	PST1	alpha-BHC	ABHC	0.00200	UGG
UB	TCL Pest	PST1	alpha-Chlordane	ACLDAN	0.00200	UGG
UB	TCL Pest	PST1	Endosulfan,A	AENSLF	0.00200	UGG
UB	TCL Pest	PST1	Aldrin	ALDRN	0.00200	UGG
UB	TCL Pest	PST1	beta-BHC	BBHC	0.00200	UGG
UB	TCL Pest	PST1	Endosulfan,B	BENSLF	0.00200	UGG
UB	TCL Pest	PST1	delta-BHC	DBHC	0.00200	UGG
UB	TCL Pest	PST1	Dieldrin	DLDRN	0.00200	UGG
UB	TCL Pest	PST1	Endrin	ENDRN	0.00200	UGG
UB	TCL Pest	PST1	Endrin Aldehyde	ENDRNA	0.00200	UGG
UB	TCL Pest	PST1	Endosulfan Sulfate	ESFSO4	0.00200	UGG
UB	TCL Pest	PST1	gamma-Chlordane	GCLDAN	0.00200	UGG
UB	TCL Pest	PST1	Heptachlor	HPCL	0.00200	UGG
UB	TCL Pest	PST1	Heptachlor Epoxide	HPCLE	0.00200	UGG
UB	TCL Pest	PST1	Lindane	LIN	0.00200	UGG
UB	TCL Pest	PST1	Methoxychlor	MEXCLR	0.02000	UGG
UB	TCL Pest	PST1	PCB-1016	PCB016	0.02000	UGG
UB	TCL Pest	PST1	PCB-1221	PCB221	0.02000	UGG
UB	TCL Pest	PST1	PCB-1232	PCB232	0.02000	UGG
UB	TCL Pest	PST1	PCB-1242	PCB242	0.02000	UGG
UB	TCL Pest	PST1	PCB-1248	PCB248	0.02000	UGG
UB	TCL Pest	PST1	PCB-1254	PCB254	0.02000	UGG
UB	TCL Pest	PST1	PCB-1260	PCB260	0.02000	UGG
UB	TCL Pest	PST1	P,P-DDD	PPDDD	0.00200	UGG
UB	TCL Pest	PST1	P,P-DDE	PPDDE	0.00200	UGG
UB	TCL Pest	PST1	P,P-DDT	PPDDT	0.00200	UGG
UB	TCL Pest	PST1	Toxaphene	TXPHEN	0.10000	UGG

Test	Method	Lab	Lot	No	Analyte	Value	Units	FLAG
EXPLOSIVES	EXL1	EL	AATE	001	4-Amino-2,6-dinitrotoluene	0.30300	UGL	J
TAL METAL	ICP1	EL	AAOQ	001	Sodium	496.00000	UGL	J
TAL METAL	ICP1	EL	AAOQ	001	Zinc	6.28000	UGL	J
TAL METAL	ICP1	EL	AAVY	001	Aluminum	50.60000	UGL	
TAL METAL	ICP1	EL	AAVY	001	Zinc	3.34000	UGL	J
TAL METAL	ICP1	EL	AAVZ	001	Beryllium	0.12700	UGL	J
TAL METAL	ICP1	EL	AAVZ	001	Sodium	255.00000	UGL	J
TAL METAL	ICP1	EL	AAVZ	001	Zinc	8.02000	UGL	J
TAL METAL	ICP1	EL	AAWA	001	Aluminum	16.80000	UGL	J
TAL METAL	ICP1	EL	AAWA	001	Zinc	10.40000	UGL	J
TAL METAL	ICP1	EL	ABEL	001	Potassium	317.00000	UGL	J
TAL METAL	ICP1	EL	ABEL	001	Zinc	5.90000	UGL	J
TAL METAL	ICP1	EL	ABGT	001	Potassium	905.00000	UGL	J
TAL METAL	ICP1	EL	ABGT	001	Sodium	1190.00000	UGL	J
TAL METAL	GPB1	EL	ABHV	001	Lead	0.68000	UGL	J
TAL METAL	GPB1	EL	ABIC	001	Lead	0.79000	UGL	J
TCL BNA	SMV1	EL	AAKM	002	C35	0.18000	UGG	
TCL BNA	SMV1	EL	AAMN	001	Di-n-butyl-phthalate	0.08200	UGG	J
TCL BNA	SMV1	EL	AAMN	002	Di-n-butyl-phthalate	0.09200	UGG	J
TCL BNA	SMV1	EL	AANC	002	C36	0.12000	UGG	
TCL BNA	SMV1	EL	AAND	002	LINOLA	16.00000	UGL	
TCL BNA	SMV1	EL	AANO	001	LINOLA	0.12000	UGG	
TCL BNA	SMV1	EL	AANP	002	2,4,6-Tribromophenyl	0.96000	UGG	
TCL BNA	SMV1	EL	AANP	001	LINOLA	0.10000	UGG	
TCL BNA	SMV1	EL	AASH	001	Bis(2-ethylhexyl)phthalate	0.04700	UGG	J
TCL BNA	SMV1	EL	AASH	002	Bis(2-ethylhexyl)phthalate	0.05500	UGG	J
TCL BNA	SMV1	EL	AASH	001	Butyl benzyl phthalate	0.05900	UGG	J
TCL BNA	SMV1	EL	AASH	002	Butyl benzyl phthalate	0.07300	UGG	J
TCL BNA	SMV1	EL	AASH	001	Di-n-butyl-phthalate	0.20000	UGG	J
TCL BNA	SMV1	EL	AASH	002	Di-n-butyl-phthalate	0.16000	UGG	J
TCL BNA	SMV1	EL	AASI	001	Diethyl phthalate	0.06500	UGG	J
TCL BNA	SMV1	EL	AASI	002	Diethyl phthalate	0.05200	UGG	J
TCL BNA	SMV1	EL	AASP	001	LINOLA	0.29000	UGG	
TCL BNA	SMV1	EL	AASS	002	Di-n-butyl-phthalate	0.09700	UGG	J
TCL BNA	SMV1	EL	AASY	001	Bis(2-ethylhexyl)phthalate	0.21000	UGG	J
TCL BNA	SMV1	EL	AASZ	001	Bis(2-chloroisopropyl) ether	0.08600	UGG	J
TCL BNA	SMV1	EL	AASZ	002	Di-n-butyl-phthalate	0.06100	UGG	J
TCL BNA	SMV1	EL	AATO	001	Bis(2-ethylhexyl)phthalate	0.05000	UGG	J
TCL BNA	SMV1	EL	AATO	002	Bis(2-ethylhexyl)phthalate	0.08300	UGG	J
TCL BNA	SMV1	EL	AATO	002	Di-n-butyl-phthalate	0.03800	UGG	J
TCL BNA	SMV1	EL	AATR	002	C36	0.20000	UGG	
TCL BNA	SMV1	EL	AAYN	001	Bis(2-ethylhexyl)phthalate	0.05800	UGG	J
TCL BNA	SMV1	EL	AAYN	002	Bis(2-ethylhexyl)phthalate	0.05900	UGG	J

Table F-2

Method Blank Hits

Table F-2

Method Blank Hits

Test	Method	Lab	Lot	No	Analyte	Value	Units	FLAG
TCL BNA	SMV1	EL	AAYO	001	Bis(2-ethylhexyl)phthalate	0.06000	UGG	J
TCL BNA	SMV1	EL	AAYO	002	Bis(2-ethylhexyl)phthalate	0.06800	UGG	J
TCL BNA	SMV1	EL	AAYP	001	Bis(2-ethylhexyl)phthalate	0.09500	UGG	J
TCL BNA	SMV1	EL	AAYP	002	Bis(2-ethylhexyl)phthalate	0.06000	UGG	J
TCL BNA	SMV1	EL	AAYZ	001	Bis(2-ethylhexyl)phthalate	0.09700	UGG	J
TCL BNA	SMV1	EL	AAYZ	002	Bis(2-ethylhexyl)phthalate	0.09800	UGG	J
TCL BNA	SMV1	EL	ABFN	002	Benzo(a)anthracene	13.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Benzo(a)pyrene	15.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Benzo(b)fluoranthene	17.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Benzo(ghi)perylene	11.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Benzo(k)fluoranthene	4.90000	UGL	J
TCL BNA	SMV1	EL	ABFN	002	Chrysene	11.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Dibenzo(a,h)anthracene	2.30000	UGL	J
TCL BNA	SMV1	EL	ABFN	002	Fluoranthene	17.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Indeno(1,2,3-cd)pyrene	11.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Phenanthrene	11.00000	UGL	
TCL BNA	SMV1	EL	ABFN	002	Pyrene	15.00000	UGL	
TCL BNA	SMV1	EL	ABGM	002	Bis(2-ethylhexyl)phthalate	11.00000	UGL	
TCL Pest	PST1	EL	AAKW	001	Endosulfan,A	0.00300	UGG	U
TCL Pest	PST1	EL	AANU	001	Endosulfan,A	0.00100	UGG	U
TCL Pest	PST1	EL	AASO	001	Heptachlor	0.04900	UGL	U
TCL Pest	PST1	EL	AAYU	001	Endosulfan,A	0.02900	UGL	U
TCL Pest	PST1	UB	AEHH	001	Endosulfan,A	0.00032	UGG	J
TCL Pest	PST1	UB	AEHH	001	Dieldrin	0.00200	UGG	J
TCL Pest	PST1	UB	AEHH	001	Endosulfan Sulfate	0.00100	UGG	J
TCL Pest	PST1	UB	AEHH	001	P,P-DDE	0.00100	UGG	J
TCL Pest	PST1	UB	AEHH	001	P,P-DDT	0.00100	UGG	J
TCL Pest	PST1	UB	AEIB	001	Endosulfan,A	0.00100	UGG	J
TCL Pest	PST1	UB	AEIB	001	Dieldrin	0.00100	UGG	J
TCL Pest	PST1	UB	AEIB	001	Endrin	0.00100	UGG	J
TCL Pest	PST1	UB	AEIB	001	Endrin Aldehyde	0.00100	UGG	J
TCL Pest	PST1	UB	AEIB	001	Endosulfan Sulfate	0.00400	UGG	
TCL Pest	PST1	UB	AEIB	001	Heptachlor Epoxide	0.00100	UGG	J
TCL Pest	PST1	UB	AEIB	001	P,P-DDT	0.00100	UGG	J
TCL Pest	PST1	UB	AEKG	001	alpha-BHC	0.00100	UGG	J
TCL Pest	PST1	UB	AEKG	001	Endosulfan,A	0.00036	UGG	J
TCL Pest	PST1	UB	AEKG	001	Lindane	0.00100	UGG	J
TCL Pest	PST1	UB	AEPJ	001	alpha-BHC	0.00039	UGG	J
TCL Pest	PST1	UB	AEPJ	001	Endosulfan,A	0.00039	UGG	J
TCL Pest	PST1	UB	AEQE	001	Endosulfan,A	0.00025	UGG	J
TCL Pest	PST1	UB	AEQE	001	Aldrin	0.00045	UGG	J
TCL Pest	PST1	UB	AEQE	001	Endrin	0.00100	UGG	J
TCL Pest	PST1	UB	AEQE	001	Endosulfan Sulfate	0.00100	UGG	J

Table F-2

Method Blank Hits

Test	Method	Lab	Lot	No	Analyte	Value	Units	FLAG
TCL Pest	PST1	UB	AEQE	001	Lindane	0.00100	UGG	J
TCL Pest	PST1	UB	AEUC	001	alpha-BHC	0.00043	UGG	J
TCL Pest	PST1	UB	AEUC	001	Endosulfan,B	0.00200	UGG	J
TCL Pest	PST1	UB	AEUC	001	Dieldrin	0.00200	UGG	
TCL Pest	PST1	UB	AEUC	001	Endrin	0.00300	UGG	
TCL Pest	PST1	UB	AEUC	001	Endosulfan Sulfate	0.00200	UGG	J
TCL Pest	PST1	UB	AEUC	001	Lindane	0.00200	UGG	J
TCL Pest	PST1	UB	AEUC	001	P,P-DDE	0.00300	UGG	
TCL Pest	PST1	UB	AEVN	001	Endosulfan,A	0.00100	UGG	J
TCL Pest	PST1	UB	AEVN	001	delta-BHC	0.00051	UGG	J
TCL Pest	PST1	UB	AEVN	001	Endrin Aldehyde	0.00200	UGG	J
TCL Pest	PST1	UB	AEVN	001	Heptachlor	0.00100	UGG	J
TCL Pest	PST1	UB	AEVN	001	Heptachlor Epoxide	0.00086	UGG	J
TCL Pest	PST1	UB	AEVN	001	P,P-DDD	0.00100	UGG	J
TCL Pest	PST1	UB	AEVN	001	P,P-DDE	0.00067	UGG	J
TCL Pest	PST1	UB	AEWV	001	alpha-BHC	0.00300	UGG	
TCL Pest	PST1	UB	AEWV	001	Endosulfan,A	0.00200	UGG	
TCL Pest	PST1	UB	AEWV	001	Aldrin	0.00300	UGG	
TCL Pest	PST1	UB	AEWV	001	delta-BHC	0.00100	UGG	J
TCL Pest	PST1	UB	AEWV	001	Dieldrin	0.00200	UGG	J
TCL Pest	PST1	UB	AEWV	001	Endrin	0.00042	UGG	J
TCL Pest	PST1	UB	AEWV	001	Endosulfan Sulfate	0.00100	UGG	J
TCL Pest	PST1	UB	AEWV	001	gamma-Chlordane	0.00100	UGG	J
TCL Pest	PST1	UB	AEWV	001	Heptachlor	0.00200	UGG	J
TCL Pest	PST1	UB	AEWV	001	Heptachlor Epoxide	0.00100	UGG	J
TCL Pest	PST1	UB	AEWV	001	Lindane	0.00200	UGG	
TCL Pest	PST1	UB	AEWV	001	P,P-DDD	0.00100	UGG	J
TCL Pest	PST1	UB	AEWV	001	P,P-DDE	0.00100	UGG	J
TCL Pest	PST1	UB	AEXB	001	alpha-BHC	0.00100	UGG	J
TCL Pest	PST1	UB	AEXB	001	alpha-Chlordane	0.00100	UGG	J
TCL Pest	PST1	UB	AEXB	001	Endosulfan,A	0.00100	UGG	J
TCL Pest	PST1	UB	AEXB	001	Aldrin	0.00044	UGG	J
TCL Pest	PST1	UB	AEXB	001	Dieldrin	0.00100	UGG	J
TCL Pest	PST1	UB	AEXB	001	Endosulfan Sulfate	0.00100	UGG	J
TCL Pest	PST1	UB	AEXB	001	Heptachlor	0.00100	UGG	J
TCL Pest	PST1	UB	AEXB	001	Lindane	0.00200	UGG	J
TCL Pest	PST1	UB	AEYR	001	Endosulfan,A	0.00300	UGG	
TCL Pest	PST1	UB	AEYR	001	Endosulfan,B	0.00100	UGG	J
TCL Pest	PST1	UB	AEYR	001	Dieldrin	0.00100	UGG	J
TCL Pest	PST1	UB	AEYR	001	Endrin	0.00200	UGG	J
TCL Pest	PST1	UB	AEYR	001	Endrin Aldehyde	0.00200	UGG	J
TCL Pest	PST1	UB	AEYR	001	gamma-Chlordane	0.00100	UGG	J
TCL Pest	PST1	UB	AEYR	001	Heptachlor Epoxide	0.00100	UGG	J

Table F-2

Method Blank Hits

Test	Method	Lab	Lot	No	Analyte	Value	Units	FLAG
TCL Pest	PST1	UB	AEYR	001	Lindane	0.00200	UGG	
TCL Pest	PST1	UB	AEYR	001	P,P-DDD	0.00100	UGG	J
TCL Pest	PST1	UB	AEYR	001	P,P-DDE	0.00100	UGG	J
TCL Pest	PST1	UB	AFOC	001	Aldrin	0.00100	UGG	J
TCL Pest	PST1	UB	AFOC	001	Endrin	0.00100	UGG	J
TCL Pest	PST1	UB	AFOC	001	Endosulfan Sulfate	0.00200	UGG	
TCL Pest	PST1	UB	AFOC	001	P,P-DDT	0.00100	UGG	J
TCL VOA	VMS1	EL	AAJY	001	Acetone	0.03700	UGG	J
TCL VOA	VMS1	EL	AAJY	002	Acetone	0.02400	UGG	J
TCL VOA	VMS1	EL	AAJY	001	Methylene chloride	0.02200	UGG	
TCL VOA	VMS1	EL	AAJY	002	Methylene chloride	0.01600	UGG	
TCL VOA	VMS1	EL	AAKT	001	Methylene chloride	0.03300	UGG	
TCL VOA	VMS1	EL	AAKT	002	Methylene chloride	0.03200	UGG	
TCL VOA	VMS1	EL	AALF	001	Methylene chloride	13.00000	UGL	
TCL VOA	VMS1	EL	AALF	002	Methylene chloride	17.00000	UGL	
TCL VOA	VMS1	EL	AALG	001	Methylene chloride	0.03000	UGG	
TCL VOA	VMS1	EL	AALG	002	Methylene chloride	0.05200	UGG	
TCL VOA	VMS1	EL	AALG	001	Toluene	0.00400	UGG	J
TCL VOA	VMS1	EL	AAMR	001	Acetone	0.02800	UGG	J
TCL VOA	VMS1	EL	AAMR	001	Methylene chloride	0.03200	UGG	
TCL VOA	VMS1	EL	AAMR	002	Methylene chloride	0.02900	UGG	
TCL VOA	VMS1	EL	AAMS	002	Chloroethane	4.50000	UGL	J
TCL VOA	VMS1	EL	AAMS	001	Methylene chloride	4.00000	UGL	J
TCL VOA	VMS1	EL	AAMT	001	Methylene chloride	0.02000	UGG	
TCL VOA	VMS1	EL	AAMT	002	Methylene chloride	0.01600	UGG	
TCL VOA	VMS1	EL	AANX	002	Acetone	0.02100	UGG	J
TCL VOA	VMS1	EL	AANX	001	Methylene chloride	0.02100	UGG	
TCL VOA	VMS1	EL	AANX	002	Methylene chloride	0.01400	UGG	
TCL VOA	VMS1	EL	AANY	001	Methylene chloride	0.01100	UGG	
TCL VOA	VMS1	EL	AANY	002	Methylene chloride	0.01400	UGG	
TCL VOA	VMS1	EL	AAOA	002	Acetone	0.02000	UGG	J
TCL VOA	VMS1	EL	AAOA	001	Methylene chloride	0.00700	UGG	J
TCL VOA	VMS1	EL	AAOA	002	Methylene chloride	0.02400	UGG	
TCL VOA	VMS1	EL	AAQK	001	Methylene chloride	0.00900	UGG	J
TCL VOA	VMS1	EL	AAQK	002	Methylene chloride	0.02700	UGG	
TCL VOA	VMS1	EL	AARX	001	Acetone	0.02100	UGG	J
TCL VOA	VMS1	EL	AARX	001	Methylene chloride	0.03200	UGG	
TCL VOA	VMS1	EL	AARX	002	Methylene chloride	0.03000	UGG	
TCL VOA	VMS1	EL	AARY	002	12DMB	0.00200	UGG	J
TCL VOA	VMS1	EL	AARY	002	134DMB	0.00600	UGG	
TCL VOA	VMS1	EL	AARY	001	Acetone	0.05900	UGG	J
TCL VOA	VMS1	EL	AARY	002	Acetone	0.08400	UGG	J
TCL VOA	VMS1	EL	AARY	001	Methylene chloride	0.00900	UGG	J

Table F-2 Method Blank Hits								
Test	Method	Lab	Lot	No	Analyte	Value	Units	FLAG
TCL VOA	VMS1	EL	AARY	002	Methylene chloride	0.01200	UGG	
TCL VOA	VMS1	EL	AARY	001	Toluene	0.00400	UGG	J
TCL VOA	VMS1	EL	AARY	002	Toluene	0.00800	UGG	
TCL VOA	VMS1	EL	AARY	001	2-Butanone	0.01100	UGG	
TCL VOA	VMS1	EL	AARY	002	2-Butanone	0.01700	UGG	
TCL VOA	VMS1	EL	AASA	001	Methylene chloride	6.50000	UGL	
TCL VOA	VMS1	EL	AASA	002	Methylene chloride	4.80000	UGL	J
TCL VOA	VMS1	EL	AASN	001	Methylene chloride	5.40000	UGL	
TCL VOA	VMS1	EL	AASN	002	Methylene chloride	6.00000	UGL	
TCL VOA	VMS1	EL	AASQ	001	Acetone	0.02600	UGG	J
TCL VOA	VMS1	EL	AASQ	001	Methylene chloride	0.04300	UGG	
TCL VOA	VMS1	EL	AASQ	002	Methylene chloride	0.06000	UGG	
TCL VOA	VMS1	EL	AASQ	001	Toluene	0.00300	UGG	J
TCL VOA	VMS1	EL	AATG	001	Methylene chloride	4.10000	UGL	J
TCL VOA	VMS1	EL	AATG	002	Methylene chloride	4.20000	UGL	J
TCL VOA	VMS1	EL	AATH	001	Methylene chloride	0.01100	UGG	
TCL VOA	VMS1	EL	AATH	002	Methylene chloride	0.01100	UGG	
TCL VOA	VMS1	EL	AATI	001	Acetone	0.04300	UGG	J
TCL VOA	VMS1	EL	AATI	002	Acetone	0.02200	UGG	J
TCL VOA	VMS1	EL	AATI	001	Methylene chloride	0.02500	UGG	
TCL VOA	VMS1	EL	AATI	002	Methylene chloride	0.00500	UGG	J
TCL VOA	VMS1	EL	AATL	001	Methylene chloride	4.30000	UGL	J
TCL VOA	VMS1	EL	AATL	002	Methylene chloride	4.00000	UGL	J
TCL VOA	VMS1	EL	AATV	001	Methylene chloride	5.10000	UGL	
TCL VOA	VMS1	EL	AATV	002	Methylene chloride	3.90000	UGL	J
TCL VOA	VMS1	EL	AATX	001	Methylene chloride	3.60000	UGL	J
TCL VOA	VMS1	EL	AAXY	001	Acetone	0.10000	UGG	
TCL VOA	VMS1	EL	AAXY	002	Acetone	0.12000	UGG	
TCL VOA	VMS1	EL	AAXY	001	Methylene chloride	0.01200	UGG	
TCL VOA	VMS1	EL	AAXY	002	Methylene chloride	0.00500	UGG	J
TCL VOA	VMS1	EL	AAXZ	001	Acetone	0.12000	UGG	
TCL VOA	VMS1	EL	AAXZ	002	Acetone	0.09200	UGG	J
TCL VOA	VMS1	EL	AAXZ	001	Toluene	0.00500	UGG	J
TCL VOA	VMS1	EL	AAXZ	002	Toluene	0.00300	UGG	J
TCL VOA	VMS1	EL	AAXZ	001	2-Butanone	0.01400	UGG	
TCL VOA	VMS1	EL	AAXZ	002	2-Butanone	0.01000	UGG	
TCL VOA	VMS1	EL	AAYB	001	Methylene chloride	3.90000	UGL	J
TCL VOA	VMS1	EL	AAYB	002	Methylene chloride	4.20000	UGL	J
TCL VOA	VMS1	EL	AAYM	001	Acetone	0.08800	UGG	J
TCL VOA	VMS1	EL	AAYM	002	Acetone	0.06800	UGG	J
TCL VOA	VMS1	EL	AAYM	001	Methylene chloride	0.01600	UGG	
TCL VOA	VMS1	EL	AAYM	002	Methylene chloride	0.01600	UGG	
TCL VOA	VMS1	EL	AAYM	001	2-Butanone	0.01000	UGG	

Table F-2

Method Blank Hits

Test	Method	Lab	Lot	No	Analyte	Value	Units	FLAG
TCL VOA	VMS1	EL	AAZI	001	Methylene chloride	0.00500	UGG	J
TCL VOA	VMS1	EL	AAZJ	001	Acetone	0.01800	UGG	J
TCL VOA	VMS1	EL	AAZJ	002	Acetone	0.04400	UGG	J
TCL VOA	VMS1	EL	AAZJ	001	Methylene chloride	0.00900	UGG	J
TCL VOA	VMS1	EL	AAZJ	002	Methylene chloride	0.00700	UGG	J
TCL VOA	VMS1	EL	AAZK	001	Acetone	0.01900	UGG	J
TCL VOA	VMS1	EL	AAZK	002	Acetone	0.03300	UGG	J
TCL VOA	VMS1	EL	AAZK	002	Methylene chloride	0.00500	UGG	J
TCL VOA	VMS1	EL	ABAG	001	Methylene chloride	0.00700	UGG	J
TCL VOA	VMS1	EL	ABAG	002	Methylene chloride	0.00800	UGG	J
TCL VOA	VMS1	EL	ABAH	001	Acetone	0.15000	UGG	
TCL VOA	VMS1	EL	ABAH	002	Acetone	0.09800	UGG	J
TCL VOA	VMS1	EL	ABAH	001	2-Butanone	0.00900	UGG	J
TCL VOA	VMS1	EL	ABAI	001	Methylene chloride	5.10000	UGL	
TCL VOA	VMS1	EL	ABAI	002	Methylene chloride	6.10000	UGL	
TCL VOA	VMS1	EL	ABAI	001	Carbon disulfide	4.80000	UGL	J
TCL VOA	VMS1	EL	ABAI	002	Carbon disulfide	6.20000	UGL	
TCL VOA	VMS1	EL	ABBE	001	Methylene chloride	3.90000	UGL	J
TCL VOA	VMS1	EL	ABBE	002	Methylene chloride	3.80000	UGL	J
TCL VOA	VMS1	EL	ABBF	001	Acetone	0.08700	UGG	J
TCL VOA	VMS1	EL	ABBF	002	Acetone	0.02100	UGG	J
TCL VOA	VMS1	EL	ABGX	001	Methylene chloride	7.80000	UGL	
TCL VOA	VMS1	EL	ABGX	002	Methylene chloride	7.00000	UGL	
TCL VOA	VMS1	EL	ABGY	001	Methylene chloride	11.00000	UGL	
TCL VOA	VMS1	EL	ABGY	002	Methylene chloride	10.00000	UGL	
TCL VOA	VMS1	EL	ABGZ	001	Methylene chloride	4.70000	UGL	J
TCL VOA	VMS1	EL	ABGZ	002	Methylene chloride	4.10000	UGL	J
TCL VOA	VMS1	EL	ABHA	001	Methylene chloride	6.30000	UGL	
TCL VOA	VMS1	EL	ABHA	002	Methylene chloride	7.90000	UGL	
TCL VOA	VMS1	EL	ABHB	001	Acetone	0.06200	UGG	J
TCL VOA	VMS1	EL	ABHB	002	Acetone	0.04400	UGG	J
TCL VOA	VMS1	EL	ABHB	001	Methylene chloride	0.00400	UGG	J
TCL VOA	VMS1	EL	ABHB	002	Methylene chloride	0.00300	UGG	J
TCL VOA	VMS1	EL	ABJN	001	Methylene chloride	12.00000	UGL	
TCL VOA	VMS1	EL	ABJN	002	Methylene chloride	19.00000	UGL	
TCL VOA	VMS1	EL	ABJN	001	Chloroform	3.60000	UGL	J

File Type: CSO
Site Type: AREA

Table: F-3

Chemical Summary Report For Surficial Soils
Units: UGL

	Site ID	E3-P42-S01					
	Field Sample ID	SR4201X1					
	Sample Date	08/03/93					
Test	Parameter .						
TAL METAL	Sodium	275 BJ					
	Zinc	5.16 BJ					
TCL BNA	Di-n-butyl-phthalate	14.0					
TCL VOA	Acetone	15.0					
	Methylene chloride	4.80 J					

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CSE
Site Type: POND

Table: F-3

Chemical Summary Report For Sediments
Units: UGL

Test	Parameter	E3-BCK-D02	E3-P13-D01	E3-P26-D01	E3-PUF-D03		
	Field Sample ID	DRBCK021	DRP13012	DR2601X1	DRPUF011		
	Sample Date	09/22/93	12/01/93	08/04/93	11/05/93		
TAL METAL	Antimony	< 5.00		< 5.00	1.36 J		
	Cadmium	< 5.00		< 5.00	2.67 J		
	Potassium	< 1000		584 J	< 1000		
	Zinc	3.92 J		< 20.0	2.36 BJ		
TCL BNA	Di-n-butyl-phthalate	< 10.0		15.0			
TCL Pest	Heptachlor	0.459 U		< 0.040	< 0.040		
TCL VOA	1,1,1-Trichloroethane	< 5.00		3.50 BJ			
	Acetone	< 10.0		25.0 B			
	Carbon disulfide	6.40 B		< 5.00			
	Chloroform	6.20		< 5.00			
	Methylene chloride	15.0 B		15.0 B			

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CSO
Site Type: EXCV

Table: F-3

Chemical Summary Report For Excavations
Units: UGL

	Site ID	E3-A08-P01	E3-A11-P02	E3-P31-B01	E3-P56-B01
	Field Sample ID	ERA08011	ERA11011	ERP31011	ERP56011
	Sample Date	09/22/93	09/23/93	09/24/93	09/20/93
Test	Parameter .				
TAL METAL	Aluminum	< 25.0	< 25.0	< 25.0	24.2 J
	Iron	< 25.0	41.4	15.6 J	15.2 J
	Zinc	11.8 J	24.9	7.88 J	1.43 J
TCL BNA	Di-n-butyl-phthalate	< 10.0	< 12.0	< 10.0	8.00 J
TCL Pest	Heptachlor	< 0.040	0.260 U	< 0.040	< 0.040
	Heptachlor Epoxide	< 0.040	< 0.048	0.240 U	< 0.040
TCL VOA	Carbon disulfide	< 5.00	< 5.00	2.50 J	< 5.00
	Chloroform	1.80 J	4.20 J	3.50 J	< 5.00
	Methylene chloride	9.70 B	10.0 B	7.70 B	4.30 BJ
WQP	Phosphorus, Total	32.0			

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CSO
Site Type: BORE

Table: F-3

Chemical Summary Report For Subsurface Soils
Units: UGL

Test	Parameter / Site ID	E3-A12-B01	E3-P01-B01	E3-P01-B04	E3-P02-B01	E3-P28-B01	E3-P36-B01
	Field Sample ID	BR1201X1	BR0101X1	BRP01042	BR0201X1	BR2801X1	BR3601X1
	Sample Date	08/10/93	08/11/93	12/01/93	08/11/93	08/09/93	08/05/93
Test	Parameter Depth	0.0 ft.	0.0 ft.	0.0 ft.	0.0 ft.	0.0 ft.	0.0 ft.
TAL METAL	Aluminum			86.3	45.3	< 25.0	11.7 J
	Arsenic			1.28 J	< 2.00	< 2.00	< 2.00
	Copper			3.53 J	< 10.0	< 10.0	< 10.0
	Iron			410	< 25.0	< 25.0	< 25.0
	Lead			0.700 BJ	< 5.00	< 5.00	< 5.00
	Manganese			3.26 J	< 5.00	< 5.00	< 5.00
	Potassium			< 1000	< 1000	< 1000	560 J
	Sodium			1010 BJ	264 BJ	< 2000	< 2000
	Zinc			11.4 J	< 20.0	6.03 BJ	4.97 BJ
TCL BNA	Bis(2-ethylhexyl)phthalate			< 10.0	< 10.0	< 10.0	11.0
	Di-n-butyl-phthalate			< 10.0	< 10.0	< 10.0	11.0
	HEDODA					13.0	
	LINOLA					16.0 B	
TCL VOA	1,1,1-Trichloroethane		< 5.00		< 5.00	< 5.00	< 5.00
	Acetone		< 10.0		< 10.0	< 10.0	16.0
	Methylene chloride		3.40 J		3.30 J	3.20 BJ	15.0 B

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CSO
Site Type: BORE

Table: F-3

Chemical Summary Report For Subsurface Soils
Units: UGL

Test	Parameter	E3-P37-B02	E3-P38-B04	E3-P48-B01			
	Field Sample ID	BR3701X1	BR3801X1	BR4801X1			
	Sample Date	08/09/93	08/10/93	08/10/93			
	Depth	0.0 ft.	0.0 ft.	0.0 ft.			
TAL METAL	Aluminum	< 25.0	16.6 J				
	Arsenic	< 2.00	2.67				
	Copper	< 10.0	< 10.0				
	Iron	86.0	18.7 J				
	Lead	< 5.00	17.2				
	Manganese	0.816 J	< 5.00				
	Potassium	549 J	< 1000				
	Sodium	< 2000	< 2000				
	Zinc	11.3 BJ	< 20.0				
TCL BNA	Bis(2-ethylhexyl)phthalate	< 10.0	< 10.0				
	Di-n-butyl-phthalate	< 10.0	< 10.0				
	HEDODA						
	LINOLA						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	3.30 BJ			
	Acetone	12.0	< 10.0	< 20.0			
	Methylene chloride	3.90 BJ	3.00 BJ	< 5.00			

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

Table: F-3

File Type: CGW
Site Type: WELL

Chemical Summary Report For Groundwater
Units: UGL

	Site ID	E3-P11-M01	E3-P11-M01	E3-P31-M01	E3-P36-M01	E3-P37-M02	E3-P58-M01
	Field Sample ID	MR1101X1	MRP11012	MRP31012	MRP36012	MRP37021	MRP58011
	Sample Date	08/24/93	11/30/93	12/03/93	12/01/93	09/02/93	09/02/93
Test	Parameter .						
EXPLOSIVES	1,3,5-Trinitrobenzene			0.231 JC			0.186 J
	1,3-Dinitrobenzene			0.567 JC			0.580 J
	2-Nitrotoluene			1.06 C			< 1.00
	3-Nitrotoluene			1.06 C			0.997 J
	4-Amino-2,6-dinitrotoluene			0.210 JC			< 1.00
TAL METAL	Aluminum	< 25.0	< 25.0		< 25.0	15.6 BJ	10.7 BJ
	Antimony	< 5.00	< 5.00		< 5.00	< 5.00	< 5.00
	Beryllium	< 5.00	< 5.00		< 5.00	< 5.00	< 5.00
	Calcium	< 500	< 500		< 500	< 500	< 500
	Iron	< 25.0	10.1 J		15.9 J	26.6 K	< 25.0
	Lead	< 5.00	< 5.00		< 5.00	< 5.00	< 5.00
	Magnesium	< 500	< 500		< 500	< 500	< 500
	Manganese	< 5.00	0.853 J		< 5.00	< 5.00	1.45 J
	Silver	< 2.00 L	< 2.00		< 2.00	< 2.00	2.20
	Sodium	< 2000	< 2000		909 BJ	< 2000	< 2000
	Zinc	< 20.0	3.16 J		< 20.0	12.1 BJ	10.4 BJ
TCL BNA	Di-n-butyl-phthalate		< 10.0	12.0	< 10.0	< 12.0	< 10.0
TCL Pest	Heptachlor	< 0.020	< 0.020	< 0.020	0.223 U	< 0.091	0.090 U
	Lindane	< 0.020	< 0.020	< 0.020	< 0.020	< 0.091	0.022 U
	P,P-DDT	< 0.040	< 0.040	< 0.040	< 0.040	< 0.180	0.043 U
TCL VOA	Acetone	< 10.0	< 10.0	19.0	< 10.0	< 10.0	< 10.0
	Carbon disulfide	< 5.00	< 5.00	< 5.00	4.10 J	4.10 J	< 5.00
	Chloroform	5.90	< 5.00	< 5.00	18.0	< 5.00	< 5.00
	Methylene chloride	< 5.00	9.40 B	6.60 B	< 5.00	< 5.00	< 5.00
TPHC	Total Petroleum Hydrocarbons	< 2000	250 J	< 2000	227 J	< 2000	< 2000

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CGW
Site Type: WELL

Table: F-3

Chemical Summary Report For Filtered Groundwater
Units: UGL

	Site ID	E3-P11-M01	E3-P13-M01	E3-P36-M01	E3-P37-M02	E3-P58-M01	
	Field Sample ID	MR1101F1	MJP11012	MJP36012	MJP37021	MJP58011	
	Sample Date	08/24/93	11/30/93	12/01/93	09/02/93	09/02/93	
Test	Parameter .						
EXPLOSIVES	1,3,5-Trinitrobenzene						
	1,3-Dinitrobenzene						
	2-Nitrotoluene						
	3-Nitrotoluene						
	4-Amino-2,6-dinitrotoluene						
TAL METAL	Aluminum	31.6 B	< 25.0	24.0 J	16.0 BJ	22.8 BJ	
	Antimony	9.45	6.53	4.38 J	8.36	9.30	
	Beryllium	0.096 J	< 5.00	< 5.00	< 5.00	< 5.00	
	Calcium	< 500	< 500	< 500	160 J	< 500	
	Iron	32.8	27.6	120	39.4 K	< 25.0	
	Lead	< 5.00	< 5.00	< 5.00	1.26 J	< 5.00	
	Magnesium	< 500	< 500	< 500	31.7 J	< 500	
	Manganese	1.86 J	2.50 J	< 5.00	1.70 J	1.42 J	
	Silver	< 2.00 L	< 2.00	< 2.00	< 2.00	< 2.00	
	Sodium	< 2000	< 2000	1040 BJ	< 2000	< 2000	
	Zinc	13.1 BJ	3.80 J	3.53 J	22.6 B	5.93 BJ	
TCL BNA	Di-n-butyl-phthalate						
TCL Pest	Heptachlor						
	Lindane						
	P,P-DDT						
TCL VOA	Acetone						
	Carbon disulfide						
	Chloroform						
	Methylene chloride						
TPHC	Total Petroleum Hydrocarbons						

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

Test	Site ID	ATEC-P1P3	E3-A05-D01	E3-A05-D01	E3-A06-M01	E3-A10-D01	E3-A10-M01
	Field Sample ID	MVP03011	DVA05011	WVA05011	MVA06011	WV1001X1	MV1001X1
	Sample Date	09/02/93	09/20/93	09/20/93	08/26/93	08/10/93	08/24/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	< 5.00	< 5.00	3.40 J	3.90 J
	Acetone	< 10.0	18.0	< 10.0	< 10.0	11.0	< 10.0
	Carbon disulfide	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Methylene chloride	< 5.00	6.00 B	6.30 B	2.80 J	4.00 J	4.10 BJ

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-A10-M01	E3-A11-P02	E3-BCK-D01	E3-BCK-D01	E3-BCK-D02	E3-BCK-D02
	Field Sample ID	MVA10013	EVA11011	DVBCK011	WVBCK011	DVBCK041	WVBCK041
	Sample Date	01/12/94	09/23/93	09/15/93	09/15/93	09/22/93	09/22/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Acetone	11.0	< 10.0	< 10.0	11.0	< 10.0	< 10.0
	Carbon disulfide	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Methylene chloride	17.0 B	3.60 BJ	< 5.00	< 5.00	3.60 BJ	3.60 BJ

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-BCK-D04	E3-BCK-D04	E3-BCK-D08	E3-BCK-D08	E3-P02-B01	E3-P11-D01
	Field Sample ID	DVBCK021	WVBCK021	DVBCK031	WVBCK031	BV0201X1	DV1101X1
	Sample Date	09/17/93	09/17/93	09/21/93	09/21/93	08/11/93	08/03/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	< 5.00	< 5.00	4.00 J	< 5.00
	Acetone	< 10.0	< 10.0	< 10.0	17.0	< 10.0	15.0
	Carbon disulfide	< 5.00	< 5.00	4.90 BJ	< 5.00	< 5.00	< 5.00
	Methylene chloride	< 5.00	< 5.00	9.50 B	6.80 B	4.00 J	6.50

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-P11-M01	E3-P13-D01	E3-P13-D01	E3-P13-M01	E3-P13-M01	E3-P16-S01
	Field Sample ID	MVP11012	DV1301X1	WV1301X1	MV1302X1	MVP13012	SVP16011
	Sample Date	11/30/93	08/02/93	08/02/93	08/25/93	11/29/93	09/01/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	< 5.00	3.60 J	< 5.00	< 5.00
	Acetone	17.0	16.0	15.0	11.0	< 10.0	< 10.0
	Carbon disulfide	4.30 J	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Methylene chloride	12.0 B	5.10	5.00 J	3.50 BJ	8.20 B	3.50 BJ

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

Test	Site ID	E3-P23-S01	E3-P26-D01	E3-P26-D01	E3-P26-D03	E3-P26-D03	E3-P26-M02
	Field Sample ID	SVP23011	DV2601X1	WV2601X1	DV2602X1	WV2602X1	MVP26023
	Sample Date	08/31/93	08/04/93	08/04/93	08/05/93	08/05/93	01/11/94
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	3.90 J	< 5.00	< 5.00	< 5.00
	Acetone	< 10.0	< 10.0	18.0	23.0	< 20.0	< 10.0
	Carbon disulfide	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Methylene chloride	< 5.00	16.0 B	16.0 B	16.0 B	16.0 B	17.0 B

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-P26-P01	E3-P26-S01	E3-P28-B01	E3-P28-B04	E3-P28-S01	E3-P31-B03
	Field Sample ID	EVP26011	SVP26011	BV2801X1	BV2802X1	SV2801X1	EVP31021
	Sample Date	09/21/93	09/14/93	08/09/93	08/09/93	08/23/93	09/23/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	< 5.00	3.40 J	3.90 J	< 5.00
	Acetone	< 10.0	< 10.0	22.0	< 10.0	< 10.0	12.0
	Carbon disulfide	3.40 BJ	< 5.00	< 5.00	< 5.00	< 5.00	2.20 J
	Methylene chloride	5.80 B	< 5.00	5.30 B	4.10 BJ	3.30 BJ	3.30 BJ

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-P36-B01	E3-P36-B03	E3-P36-M01	E3-P36-S01	E3-P36-S07	E3-P37-B01
	Field Sample ID	BV3601X1	BV3602X1	MVP36011	SV3601X1	SV3602X1	BV3702X1
	Sample Date	08/05/93	08/13/93	09/01/93	08/25/93	08/24/93	08/09/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	4.00 J	< 5.00	< 5.00	4.00 J	3.40 J
	Acetone	< 20.0	< 10.0	< 10.0	< 10.0	9.80 J	< 10.0
	Carbon disulfide	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Methylene chloride	16.0 B	4.00 J	3.10 BJ	3.50 BJ	4.40 BJ	4.60 BJ

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

Table F-4

File Type: CQC
Site Type: TRIP

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-P37-D01	E3-P37-D01	E3-P37-D02	E3-P37-M01	E3-P37-M01	E3-P37-S01
	Field Sample ID	DVP37011	WVP37011	BV3701X1	MVP37011	MVP37012	SV3701X1
	Sample Date	09/16/93	09/16/93	08/06/93	09/02/93	12/01/93	08/16/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	3.20 J	< 5.00	< 5.00	4.00 J
	Acetone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Carbon disulfide	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Methylene chloride	< 5.00	< 5.00	4.30 BJ	< 5.00	4.10 BJ	3.70 J

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-P38-B04	E3-P38-S01	E3-P45-S01	E3-P48-B01	E3-P52-S01	E3-P57-S01
	Field Sample ID	BV3801X1	SV3801X1	SVP45012	BV4801X1	SVP52011	SVP57011
	Sample Date	08/10/93	08/25/93	11/30/93	08/10/93	08/30/93	08/26/93
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	3.20 J	< 5.00	< 5.00	3.80 J	< 5.00	< 5.00
	Acetone	< 10.0	< 10.0	19.0	< 10.0	< 10.0	< 10.0
	Carbon disulfide	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
	Methylene chloride	3.90 J	3.60 BJ	12.0 B	3.50 J	< 5.00	< 5.00

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

File Type: CQC
Site Type: TRIP

Table F-4

Chemical Summary Report For Trip Blanks
Units: UGL

	Site ID	E3-P58-M01	OHM-A8-15	OHM-P40-39	USAF		
	Field Sample ID	MVP58012	MVA08011	MVP40011	MVBKD011		
	Sample Date	12/02/93	08/30/93	08/31/93	09/03/93		
Test	Parameter .						
TCL VOA	1,1,1-Trichloroethane	< 5.00	< 5.00	< 5.00	< 5.00		
	Acetone	< 10.0	< 10.0	< 10.0	< 10.0		
	Carbon disulfide	< 5.00	< 5.00	< 5.00	< 5.00		
	Methylene chloride	6.10 B	< 5.00	< 5.00	5.20 B		

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

Date: 03/15/94	Table: F-5
File Type: CSE	Chemical Summary Report For Sediments
Site Type: POND	Area of Contamination: FW
	Units: UGG

	Site ID	E3-BCK-D02	E3-BCK-D02		
	Field Sample ID	DDBCK021	DXBCK021		
	Sample Date	09/22/93	09/22/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	3700	3720	3710	0.5%
	Arsenic	4.25	5.86	5.055	31.8%
	Barium	16.8	20.4	18.6	19.4%
	Beryllium	0.118	0.115	0.1165	2.6%
	Cadmium	< 0.500	< 0.500	ERR	ERR
	Calcium	636	639	637.5	0.5%
	Chromium	10.6	9.16	9.88	14.6%
	Cobalt	4.21	4.70	4.455	11.0%
	Copper	9.25	7.65	8.45	18.9%
	Iron	6730	6430	6580	4.6%
	Lead	37.0	34.0	35.5	8.5%
	Magnesium	1690	1590	1640	6.1%
	Manganese	63.4	66.5	64.95	4.8%
	Nickel	7.59	7.42	7.505	2.3%
	Potassium	806	893	849.5	10.2%
	Selenium	< 0.200	< 0.200	ERR	ERR
	Sodium	71.3 F	87.7 F	ERR	ERR
	Vanadium	11.9	13.1	12.5	9.6%
	Zinc	19.0	21.9	20.45	14.2%
TCL Pest	Endosulfan,B	0.002	< 0.002	ERR	ERR
	Endrin Aldehyde	0.006	0.004	0.005	40.0%
	Heptachlor Epoxide	0.001	0.001	0.001	0.0%
	P,P-DDD	0.008	0.085	0.0465	165.6%
	P,P-DDE	0.004	0.036	0.02	160.0%
	P,P-DDT	0.010	0.045	0.0275	127.3%
	gamma-Chlordane	0.001	0.001	0.001	0.0%
TCL VOA	Carbon disulfide	0.004 F	< 0.005	ERR	ERR
TOC	Total Organic Carbon	41200	27600	34400	39.5%
TPHC	Total Petroleum Hydrocarbons	1200	482	841	85.4%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSE
Site Type: POND

Table: F-5
Chemical Summary Report For Sediments
Area of Contamination: FW
Units: UGG

	Site ID	E3-PUF-D02	E3-PUF-D02		
	Field Sample ID	DDPUF021	DXPUF021		
	Sample Date	11/05/93	11/05/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	6710	8170	7440	19.6%
	Arsenic	34.1	32.7	33.4	4.2%
	Barium	40.0	49.6	44.8	21.4%
	Beryllium	< 0.500	< 0.500	ERR	ERR
	Cadmium	< 0.500	1.69 X	ERR	ERR
	Calcium	5160	6430	5795	21.9%
	Chromium	13.5	16.3	14.9	18.8%
	Cobalt	9.66	12.3	10.98	24.0%
	Copper	7.76	10.3	9.03	28.1%
	Iron	13900	17600	15750	23.5%
	Lead	22.1	27.0	24.55	20.0%
	Magnesium	829	1100	964.5	28.1%
	Manganese	161	204	182.5	23.6%
	Nickel	12.7	16.7	14.7	27.2%
	Potassium	950	458 X	ERR	ERR
	Selenium	1.42	2.47	1.945	54.0%
	Sodium	428	491	459.5	13.7%
	Vanadium	14.2	18.0	16.1	23.6%
	Zinc	54.2	77.2	65.7	35.0%
TCL Pest	Endosulfan,B	< 0.010	< 0.010	ERR	ERR
	Endrin Aldehyde	< 0.010	< 0.010	ERR	ERR
	Heptachlor Epoxide	< 0.005	< 0.005	ERR	ERR
	P,P-DDD	< 0.010	0.065	ERR	ERR
	P,P-DDE	< 0.010	< 0.010	ERR	ERR
	P,P-DDT	< 0.010	< 0.010	ERR	ERR
	gamma-Chlordane			0	ERR
TCL VOA	Carbon disulfide			0	ERR
TOC	Total Organic Carbon	334000	336000	335000	0.6%
TPHC	Total Petroleum Hydrocarbons			0	ERR

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSE
Site Type: POND

Table: F-5
Chemical Summary Report For Sediments
Area of Contamination: P13
Units: UGG

	Site ID	E3-P13-D01	E3-P13-D01		
	Field Sample ID	DD1301X1	DX1301X1		
	Sample Date	08/02/93	08/02/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	5280	4100	4690	25.2%
	Arsenic	11.2	9.86	10.53	12.7%
	Barium	59.5	59.0	59.25	0.8%
	Beryllium	0.697	0.566	0.6315	20.7%
	Calcium	20200	19400	19800	4.0%
	Chromium	11.3	9.79	10.545	14.3%
	Cobalt	10.7	9.10	9.9	16.2%
	Copper	34.0	9.10	21.55	115.5%
	Iron	140000	13000	76500	166.0%
	Lead	72.2	69.7	70.95	3.5%
	Magnesium	2350	1980	2165	17.1%
	Manganese	66.6	76.6	71.6	14.0%
	Nickel	29.1	23.9	26.5	19.6%
	Selenium	2.65	1.94	2.295	30.9%
	Vanadium	30.9	22.9	26.9	29.7%
	Zinc	269	277	273	2.9%
TCL Pest	P,P-DDD	0.690	0.760	0.725	9.7%
	P,P-DDE	0.480	0.540	0.51	11.8%
	P,P-DDT	0.110	0.150	0.13	30.8%
TOC	Total Organic Carbon	592000	628000	610000	5.9%
TPHC	Total Petroleum Hydrocarbons	55.1	295	175.05	137.0%

Source: USAEC IRDMIS Level 3/E & E, 1994

Date: 03/15/94
File Type: CSE
Site Type: POND

Table: F-5
Chemical Summary Report For Sediments
Area of Contamination: P39
Units: UGG

	Site ID	E3-P39-D01	E3-P39-D01		
	Field Sample ID	DD3901X1	DX3901X1		
	Sample Date	08/11/93	08/11/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	1540	1810	1675	16.1%
	Arsenic	1.98	2.54	2.26	24.8%
	Copper	4.35	4.98	4.665	13.5%
	Iron	< 350	1990	ERR	ERR
	Lead	22.5	27.9	25.2	21.4%
	Manganese	6.37	11.2	8.785	55.0%
	Nickel	5.87	5.22	5.545	11.7%
	Selenium	1.07	1.07	1.07	0.0%
	Vanadium	5.77	9.02	7.395	43.9%
	Zinc	38.2	45.3	41.75	17.0%
TCL Pest	P,P-DDD	< 0.020	0.006	ERR	ERR
	P,P-DDE	< 0.020	0.010	ERR	ERR
TCL VOA	Carbon disulfide	0.023 F	0.080	ERR	ERR
TOC	Total Organic Carbon	656000	666000	661000	1.5%
TPHC	Total Petroleum Hydrocarbons	117	375	246	104.9%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P54
Units: UGG

	Site ID	E3-P54-S02	E3-P54-S02		
	Field Sample ID	SDP54022	SXP54022		
	Sample Date	12/01/93	12/01/93		
Test	Parameter .			Mean	RPD
TCL BNA	Benzo(b)fluoranthene	0.071	0.086	0.0785	19.1%
	Bis(2-ethylhexyl)phthalate	0.077	< 0.330	ERR	ERR
	Fluoranthene	0.110	0.140	0.125	24.0%
	LINOLA	0.460		0.23	200.0%
	Phenanthrene	< 0.330	0.076	ERR	ERR
	Pyrene	0.097	0.120	0.1085	21.2%

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C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P09
Units: UGG

	Site ID	E3-P09-S01	E3-P09-S01		
	Field Sample ID	SDP09011	SXP09011		
	Sample Date	09/14/93	09/14/93		
Test	Parameter			Mean	RPD
TAL METAL	Aluminum	7480	7150	7315	4.5%
	Antimony	2.47	2.47	2.47	0.0%
	Arsenic	200	220	210	9.5%
	Barium	25.7	25.1	25.4	2.4%
	Beryllium	0.318	0.281	0.2995	12.4%
	Calcium	422	403	412.5	4.6%
	Chromium	14.3	12.3	13.3	15.0%
	Cobalt	5.23	5.23	5.23	0.0%
	Copper	11.5	10.4	10.95	10.0%
	Iron	10500	9700	10100	7.9%
	Lead	17.0	15.0	16	12.5%
	Magnesium	2180	2210	2195	1.4%
	Manganese	83.4	85.5	84.45	2.5%
	Nickel	9.83	9.62	9.725	2.2%
	Potassium	1160	1210	1185	4.2%
	Sodium	170 X	129 F	ERR	ERR
	Vanadium	19.5	17.6	18.55	10.2%
	Zinc	26.8	32.3	29.55	18.6%
TCL BNA	Acenaphthylene	< 0.330	0.043	ERR	ERR
	Benzo(a)anthracene	0.120	0.230	0.175	62.9%
	Benzo(a)pyrene	0.200	0.330	0.265	49.1%
	Benzo(b)fluoranthene	0.280	0.450	0.365	46.6%
	Benzo(ghi)perylene	0.150	0.210	0.18	33.3%
	Benzo(k)fluoranthene	0.083	0.110	0.0965	28.0%
	Chrysene	0.190	0.280	0.235	38.3%
	Fluoranthene	0.220	0.360	0.29	48.3%
	Indeno(1,2,3-cd)pyrene	0.160	0.160	0.16	0.0%
TCL BNA	Phenanthrene	0.091	0.120	0.1055	27.5%
	Pyrene	0.300	0.450	0.375	40.0%
TCL Pest	Dieldrin	0.009	0.010	0.0095	10.5%
	Endosulfan A	0.001	0.001	0.001	0.0%
	Endosulfan,B	0.005	0.005	0.005	0.0%
	Endrin	0.039	0.021	0.03	60.0%
	Heptachlor Epoxide	0.003	0.003	0.003	0.0%
	Lindane	0.001	< 0.002	ERR	ERR
	P,P-DDD	0.022	0.031	0.0265	34.0%
	P,P-DDE	0.029	0.031	0.03	6.7%
	P,P-DDT	0.058	0.089	0.0735	42.2%
	alpha-Chlordane	0.008	0.004	0.006	66.7%
	gamma-Chlordane	0.004	0.002	0.003	66.7%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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Date: 03/15/94	Table: F-5
File Type: CSO	Chemical Summary Report For Surficial Soils
Site Type: AREA	Area of Contamination: P22
	Units: UGG

Test	Parameter	E3-P22-S01	E3-P22-S01	Mean	RPD
	Field Sample ID	SDP22011	SXP22011		
	Sample Date	09/14/93	09/14/93		
TAL METAL	Aluminum	6850	7790	7320	12.8%
	Antimony	0.757 X	0.546 F	ERR	ERR
	Arsenic	9.36	10.6	9.98	12.4%
	Barium	22.9	22.5	22.7	1.8%
	Beryllium	0.299	0.296	0.2975	1.0%
	Cadmium	0.968 F	0.146 F	ERR	ERR
	Calcium	432	1020	726	81.0%
	Chromium	14.6	15.9	15.25	8.5%
	Cobalt	8.30	7.52	7.91	9.9%
	Copper	13.5	16.7	15.1	21.2%
	Iron	15000	13000	14000	14.3%
	Lead	90.0	81.0	85.5	10.5%
	Magnesium	259400	299400	279400	14.3%
	Manganese	176	175	175.5	0.6%
	Nickel	15.5	14.3	14.9	8.1%
	Potassium	1270	1210	1240	4.8%
	Sodium	48.1 F	170 X	ERR	ERR
	Vanadium	16.8	20.7	18.75	20.8%
	Zinc	35.5	45.3	40.4	24.3%
TCL BNA	BJFANT	0.220	0.200	0.21	9.5%
	Benzo(a)anthracene	0.160	0.140	0.15	13.3%
	Benzo(a)pyrene	0.210	0.200	0.205	4.9%
	Benzo(b)fluoranthene	0.240	0.210	0.225	13.3%
	Benzo(ghi)perylene	0.110	0.140	0.125	24.0%
	Benzo(k)fluoranthene	0.068	< 0.330	ERR	ERR
	Chrysene	0.220	0.180	0.2	20.0%
	Fluoranthene	0.110	0.110	0.11	0.0%
TCL BNA	Indeno(1,2,3-cd)pyrene	0.120	0.120	0.12	0.0%
	Phenanthrene	0.050	0.050	0.05	0.0%
	Pyrene	0.130	0.130	0.13	0.0%
TCL Pest	Dieldrin	0.001	0.001	0.001	0.0%
	Endosulfan,A	0.000	< 0.002	ERR	ERR
	Endosulfan,B	0.002	0.001	0.0015	66.7%
	Heptachlor Epoxide	0.001	< 0.002	ERR	ERR
	Lindane	< 0.002	0.001	ERR	ERR
	P,P-DDD	0.006	0.005	0.0055	18.2%
	P,P-DDE	0.004	0.004	0.004	0.0%
	P,P-DDT	0.010	0.010	0.01	0.0%
	alpha-BHC	0.000	< 0.002	ERR	ERR
	alpha-Chlordane	0.000	< 0.002	ERR	ERR

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: A10
Units: UGG

	Site ID	E3-A10-S01	E3-A10-S01		
	Field Sample ID	SDA10011	SXA10011		
	Sample Date	09/14/93	09/14/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	1,3-Dinitrobenzene	< 1.00	0.382	ERR	ERR
TAL METAL	Aluminum	6680	6290	6485	6.0%
	Arsenic	5.46	5.65	5.555	3.4%
	Barium	19.8	18.8	19.3	5.2%
	Beryllium	0.241	0.234	0.2375	2.9%
	Cadmium	0.379 F	0.513 F	ERR	ERR
	Calcium	328	401	364.5	20.0%
	Chromium	9.85	9.87	9.86	0.2%
	Cobalt	5.38	5.28	5.33	1.9%
	Copper	9.42	1.15	5.285	156.5%
	Iron	7750	7780	7765	0.4%
	Lead	18.0	25.0	21.5	32.6%
	Magnesium	1560	1620	1590	3.8%
	Manganese	142	141	141.5	0.7%
	Nickel	9.78	9.36	9.57	4.4%
	Potassium	637	651	644	2.2%
	Sodium	71.8 F	75.8 F	ERR	ERR
	Vanadium	13.1	13.3	13.2	1.5%
	Zinc	81.4	96.8	89.1	17.3%
TPHC	Total Petroleum Hydrocarbons	39.8	41.9	40.85	5.1%

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J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P06
Units: UGG

	Site ID	E3-P06-S01		E3-P06-S01			
	Field Sample ID	SDP06011		SXP06011			
	Sample Date	09/14/93		09/14/93			
Test	Parameter .					Mean	RPD
TAL METAL	Aluminum	4610		4940		4775	6.9%
	Arsenic	38.0		34.0		36	11.1%
	Barium	10.9		11.6		11.25	6.2%
	Beryllium	0.166		0.181		0.1735	8.6%
	Calcium	291		287		289	1.4%
	Chromium	6.06		6.13		6.095	1.1%
	Cobalt	2.63		2.76		2.695	4.8%
	Copper	4.36		4.46		4.41	2.3%
	Iron	6130		6680		6405	8.6%
	Lead	86.0		76.0		81	12.3%
	Magnesium	850		921		885.5	8.0%
	Manganese	56.2		66.1		61.15	16.2%
	Nickel	5.64		6.56		6.1	15.1%
	Potassium	280	F	259	F	ERR	ERR
	Sodium	139	X	122	F	ERR	ERR
	Vanadium	9.73		9.86		9.795	1.3%
	Zinc	33.0		30.1		31.55	9.2%
TCL Pest	Dieldrin	0.002		0.001		0.0015	66.7%
	Endrin	0.003		0.001	B	ERR	ERR
	Heptachlor Epoxide	0.001		< 0.002		ERR	ERR
	Lindane	0.001		0.002	B	ERR	ERR
	P,P-DDD	< 0.002		0.003		ERR	ERR
	P,P-DDE	0.011		0.007		0.009	44.4%
	P,P-DDT	0.014		0.005		0.0095	94.7%
	alpha-Chlordane	< 0.002		0.000		ERR	ERR
TPHC	Total Petroleum Hydrocarbons	37.6		37.7		37.65	0.3%

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J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P45
Units: UGG

	Site ID	E3-P45-S01	E3-P45-S01		
	Field Sample ID	SDP45011	SXP45011		
	Sample Date	09/01/93	09/01/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	10600	12000	11300	12.4%
	Antimony	< 0.500	0.168 F	ERR	ERR
	Arsenic	5.98	5.42	5.7	9.8%
	Barium	18.4	21.0	19.7	13.2%
	Beryllium	0.408	0.445	0.4265	8.7%
	Calcium	237	245	241	3.3%
	Chromium	16.4	17.8	17.1	8.2%
	Cobalt	4.65	5.15	4.9	10.2%
	Copper	7.44	8.39	7.915	12.0%
	Iron	9580	10300	9940	7.2%
	Lead	14.0	17.0	15.5	19.4%
	Magnesium	1500	1560	1530	3.9%
	Manganese	134	150	142	11.3%
	Mercury	< 0.100	0.133	ERR	ERR
	Nickel	8.82	9.16	8.99	3.8%
	Potassium	306 X	335 X	ERR	ERR
	Selenium	0.321	0.347	0.334	7.8%
	Vanadium	15.0	16.0	15.5	6.5%
	Zinc	23.4	20.4	21.9	13.7%
TCL BNA	1DTCTL	2.10		1.05	200.0%
TCL Pest	Dieldrin			0	ERR
	Endosulfan,B			0	ERR
	Endrin			0	ERR
	Heptachlor Epoxide			0	ERR
	P,P-DDD			0	ERR
	P,P-DDE			0	ERR
	P,P-DDT			0	ERR
TOC	Total Organic Carbon	32500	49200	40850	40.9%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P45
Units: UGG

	Site ID	E3-P45-S01	E3-P45-S01		
	Field Sample ID	SXP45011	SDP45011		
	Sample Date	09/15/93	09/15/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum			0	ERR
	Antimony			0	ERR
	Arsenic			0	ERR
	Barium			0	ERR
	Beryllium			0	ERR
	Calcium			0	ERR
	Chromium			0	ERR
	Cobalt			0	ERR
	Copper			0	ERR
	Iron			0	ERR
	Lead			0	ERR
	Magnesium			0	ERR
	Manganese			0	ERR
	Mercury			0	ERR
	Nickel			0	ERR
	Potassium			0	ERR
	Selenium			0	ERR
	Vanadium			0	ERR
	Zinc			0	ERR
TCL BNA	1DTCTL			0	ERR
TCL Pest	Dieldrin	0.002	< 0.002	ERR	ERR
	Endosulfan,B	0.003	0.001	0.002	100.0%
	Endrin	0.005 K	0.001 B	ERR	ERR
	Heptachlor Epoxide	0.001	< 0.002	ERR	ERR
	P,P-DDD	0.012	0.003	0.0075	120.0%
	P,P-DDE	0.007	0.007	0.007	0.0%
	P,P-DDT	0.010	0.005	0.0075	66.7%
TOC	Total Organic Carbon			0	ERR

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94	Table: F-5
File Type: CSO	Chemical Summary Report For Surficial Soils
Site Type: AREA	Area of Contamination: P23
	Units: UGG

	Site ID	E3-P23-S01	E3-P23-S01		
	Field Sample ID	SDP23011	SXP23011		
	Sample Date	08/31/93	08/31/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	4440	4040	4240	9.4%
	Antimony	0.370 F	0.310 F	ERR	ERR
	Arsenic	10.3	13.0	11.65	23.2%
	Barium	22.4	18.4	20.4	19.6%
	Beryllium	0.226	0.202	0.214	11.2%
	Cadmium	1.23 F	1.02 F	ERR	ERR
	Calcium	469	415	442	12.2%
	Chromium	13.3	11.9	12.6	11.1%
	Cobalt	5.13	4.74	4.935	7.9%
	Copper	12.0	10.8	11.4	10.5%
	Iron	6710	6340	6525	5.7%
	Lead	31.0	33.0	32	6.3%
	Magnesium	1430	1220	1325	15.8%
	Manganese	144	120	132	18.2%
	Mercury	0.108	0.129	0.1185	17.7%
	Nickel	13.4	13.6	13.5	1.5%
	Potassium	1080	759	919.5	34.9%
	Vanadium	11.0	9.87	10.435	10.8%
	Zinc	32.9	30.8	31.85	6.6%
TCL BNA	Benzo(b)fluoranthene	0.036	< 0.330	ERR	ERR
	Fluoranthene	0.042	< 0.330	ERR	ERR
	Pyrene	0.036	< 0.330	ERR	ERR.
	TCPP	0.250		0.125	200.0%
TCL Pest	Dieldrin	0.002 B	0.001	ERR	ERR
	Endosulfan,A	0.001 B	0.001	ERR	ERR
	Endrin	0.007	0.003	0.005	80.0%
	Endrin Aldehyde	0.035	< 0.002	ERR	ERR
	Heptachlor Epoxide	0.001	0.001	0.001	0.0%
	P,P-DDD	0.014	< 0.002	ERR	ERR
	P,P-DDE	0.030	0.038	0.034	23.5%
	P,P-DDT	0.081	0.150	0.1155	59.7%
TCL Pest	alpha-Chlordane	0.003	0.003	0.003	0.0%
	gamma-Chlordane	0.004	0.004	0.004	0.0%
TOC	Total Organic Carbon	12700	13500	13100	6.1%
TPHC	Total Petroleum Hydrocarbons	36.0	44.4	40.2	20.9%

J= Estimated value. L= Result bias low. @= Exceeds Health ARA
K= Result bias high. R= Result rejected. != Exceeds Background.

Date: 03/15/94 File Type: CSO Site Type: AREA	Table: F-5 Chemical Summary Report For Surficial Soils Area of Contamination: P16 Units: UGG

	Site ID	E3-P16-S01	E3-P16-S01		
	Field Sample ID	SDP16011	SXP16011		
	Sample Date	08/31/93	08/31/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	4510	5680	5095	23.0%
	Antimony	0.439 F	0.622 F	ERR	ERR
	Arsenic	41.0	35.0	38	15.8%
	Barium	19.5	22.2	20.85	12.9%
	Beryllium	0.245	0.310	0.2775	23.4%
	Cadmium	0.182 F	0.223 F	ERR	ERR
	Calcium	718	556	637	25.4%
	Chromium	11.2	13.9	12.55	21.5%
	Cobalt	5.07	7.27	6.17	35.7%
	Copper	9.19	12.3	10.745	28.9%
	Iron	6790	9380	8085	32.0%
	Lead	22.0	14.0	18	44.4%
	Magnesium	1630	2070	1850	23.8%
	Manganese	140	192	166	31.3%
	Nickel	13.7	13.8	13.75	0.7%
	Potassium	989	1120	1054.5	12.4%
	Vanadium	12.9	14.9	13.9	14.4%
	Zinc	20.1	23.3	21.7	14.7%
TCL BNA	Anthracene	< 0.330	0.064	ERR	ERR
	Benzo(a)anthracene	0.360	0.210	0.285	52.6%
	Benzo(a)pyrene	0.240	0.190	0.215	23.3%
	Benzo(b)fluoranthene	0.420	0.310	0.365	30.1%
	Benzo(ghi)perylene	0.170	0.140	0.155	19.4%
	Benzo(k)fluoranthene	0.180	0.160	0.17	11.8%
	Chrysene	0.450	0.310	0.38	36.8%
	Fluoranthene	0.600	0.540	0.57	10.5%
	Indeno(1,2,3-cd)pyrene	0.150	0.130	0.14	14.3%
TCL BNA	NCHRYS	0.140	0.091	0.1155	42.4%
	Phenanthrene	0.055	0.280	0.1675	134.3%
	Pyrene	0.580	0.500	0.54	14.8%
TCL Pest	Aldrin	0.001	0.001	0.001	0.0%
	Dieldrin	0.013 K	0.005 B	ERR	ERR
	Endosulfan,B	0.005	0.001	0.003	133.3%
	Heptachlor Epoxide	0.001	< 0.002	ERR	ERR
	Lindane	0.001	0.001	0.001	0.0%
	P,P-DDD	0.015	0.005	0.01	100.0%
	P,P-DDE	0.018	0.007 K	ERR	ERR
	P,P-DDT	0.053	0.017	0.035	102.9%
	alpha-BHC	< 0.002	0.002	ERR	ERR
TOC	Total Organic Carbon	14100	6560	10330	73.0%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P16
Units: UGG

Test	Parameter .	E3-P16-S10	E3-P16-S10	Mean	RPD
	Field Sample ID	SDP16102	SXP16102		
	Sample Date	12/01/93	12/01/93		
TAL METAL	Aluminum			0	ERR
	Antimony			0	ERR
	Arsenic			0	ERR
	Barium			0	ERR
	Beryllium			0	ERR
	Cadmium			0	ERR
	Calcium			0	ERR
	Chromium			0	ERR
	Cobalt			0	ERR
	Copper			0	ERR
	Iron			0	ERR
	Lead			0	ERR
	Magnesium			0	ERR
	Manganese			0	ERR
	Nickel			0	ERR
	Potassium			0	ERR
	Vanadium			0	ERR
	Zinc			0	ERR
TCL BNA	Anthracene	< 0.330	< 0.330	ERR	ERR
	Benzo(a)anthracene	< 0.330	< 0.330	ERR	ERR
	Benzo(a)pyrene	< 0.330	< 0.330	ERR	ERR
	Benzo(b)fluoranthene	< 0.330	0.057	ERR	ERR
	Benzo(ghi)perylene	< 0.330	< 0.330	ERR	ERR
	Benzo(k)fluoranthene	< 0.330	< 0.330	ERR	ERR
	Chrysene	< 0.330	< 0.330	ERR	ERR
	Fluoranthene	< 0.330	0.080	ERR	ERR
	Indeno(1,2,3-cd)pyrene	< 0.330	< 0.330	ERR	ERR
TCL BNA	NCHRYS			0	ERR
	Phenanthrene	< 0.330	< 0.330	ERR	ERR
	Pyrene	< 0.330	< 0.330	ERR	ERR
TCL Pest	Aldrin			0	ERR
	Dieldrin			0	ERR
	Endosulfan,B			0	ERR
	Heptachlor Epoxide			0	ERR
	Lindane			0	ERR
	P,P-DDD			0	ERR
	P,P-DDE			0	ERR
	P,P-DDT			0	ERR
	alpha-BHC			0	ERR
TOC	Total Organic Carbon			0	ERR

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P52
Units: UGG

	Site ID	E3-P52-S01	E3-P52-S01		
	Field Sample ID	SDP52011	SXP52011		
	Sample Date	08/30/93	08/30/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	4-Amino-2,6-dinitrotoluene	0.210	0.197	0.2035	6.4%
TAL METAL	Aluminum	7950	8540	8245	7.2%
	Arsenic	14.0	14.0	14	0.0%
	Barium	24.6	28.0	26.3	12.9%
	Beryllium	0.390	0.446	0.418	13.4%
	Cadmium	0.564 F	0.726 F	ERR	ERR
	Calcium	382	557	469.5	37.3%
	Chromium	11.0	11.7	11.35	6.2%
	Cobalt	4.71	4.59	4.65	2.6%
	Copper	9.40	10.4	9.9	10.1%
	Iron	12000	12000	12000	0.0%
	Lead	70.0	75.0	72.5	6.9%
	Magnesium	957	933	945	2.5%
	Manganese	97.9	118	107.95	18.6%
	Nickel	11.8	11.5	11.65	2.6%
	Potassium	327 X	310 X	ERR	ERR
	Selenium	0.420	0.327	0.3735	24.9%
	Vanadium	16.2	17.4	16.8	7.1%
	Zinc	160	180	170	11.8%
TCL BNA	Benzo(b)fluoranthene	0.052	< 0.330	ERR	ERR
	Pyrene	0.056	< 0.330	ERR	ERR
TCL Pest	Dieldrin	0.002	0.002	0.002	0.0%
	Lindane	0.001	0.001	0.001	0.0%
	P,P-DDE	0.033	0.037	0.035	11.4%
	P,P-DDT	0.056	0.065	0.0605	14.9%
TOC	Total Organic Carbon	71300	76600	73950	7.2%

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P52
Units: UGG

	Site ID	E3-P57-S01	E3-P57-S01		
	Field Sample ID	SDP57011	SXP57011		
	Sample Date	08/26/93	08/26/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	9700	9460	9580	2.5%
	Arsenic	7.37	6.34	6.855	15.0%
	Barium	19.7	21.7	20.7	9.7%
	Beryllium	0.332	0.329	0.3305	0.9%
	Cadmium	0.220 F	< 0.500	ERR	ERR
	Chromium	13.6	12.9	13.25	5.3%
	Cobalt	4.22	4.52	4.37	6.9%
	Copper	10.8	11.8	11.3	8.8%
	Iron	10700	10300	10500	3.8%
	Lead	24.0	25.0	24.5	4.1%
	Magnesium	1430	1390	1410	2.8%
	Manganese	88.3	83.6	85.95	5.5%
	Nickel	8.09	8.38	8.235	3.5%
	Potassium	437 X	489 X	ERR	ERR
	Selenium	0.544	0.314	0.429	53.6%
	Sodium	149 X	< 200	ERR	ERR
	Vanadium	19.8	19.0	19.4	4.1%
	Zinc	28.7	31.1	29.9	8.0%
TCL BNA	Anthracene	0.042	0.077	0.0595	58.8%
	Benzo(a)anthracene	1.10	0.740	0.92	39.1%
	Benzo(a)pyrene	0.760	0.480	0.62	45.2%
	Benzo(b)fluoranthene	1.30	0.730	1.015	56.2%
	Benzo(ghi)perylene	0.400	0.180	0.29	75.9%
	Benzo(k)fluoranthene	0.420	0.360	0.39	15.4%
	Chrysene	1.30	0.790	1.045	48.8%
	Dibenzo(a,h)anthracene	0.150	< 0.330	ERR	ERR
	Fluoranthene	1.00	1.10	1.05	9.5%
TCL BNA	Indeno(1,2,3-cd)pyrene	0.430	0.230	0.33	60.6%
	Phenanthrene	0.140	0.230	0.185	48.6%
	Pyrene	1.60	1.30	1.45	20.7%
TCL Pest	Dieldrin	0.015	0.012	0.0135	22.2%
	Endosulfan,B	0.006	0.005	0.0055	18.2%
	Methoxychlor	0.022	< 0.020	ERR	ERR
	P,P-DDE	0.930	0.500	0.715	60.1%
	P,P-DDT	1.90	1.00	1.45	62.1%
TOC	Total Organic Carbon	61500	69700	65600	12.5%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: AREA

Table: F-5
Chemical Summary Report For Surficial Soils
Area of Contamination: P52
Units: UGG

Test	Parameter				
	Site ID	E3-P36-S01	E3-P36-S01		
	Field Sample ID	SD3601X1	SX3601X1		
	Sample Date	08/25/93	08/25/93	Mean	RPD
TAL METAL	Aluminum	5740	5860	5800	2.1%
	Antimony	5.39	6.09	5.74	12.2%
	Arsenic	13.0	15.0	14	14.3%
	Barium	150	250	200	50.0%
	Beryllium	0.248	0.285	0.2665	13.9%
	Cadmium	4.83	4.60	4.715	4.9%
	Calcium	2070	2040	2055	1.5%
	Chromium	35.4	40.5	37.95	13.4%
	Cobalt	20.9	21.3	21.1	1.9%
	Copper	93.8	94.9	94.35	1.2%
	Iron	67000	58000	62500	14.4%
	Lead	230	290	260	23.1%
	Magnesium	3440	3130	3285	9.4%
	Manganese	362	331	346.5	8.9%
	Nickel	45.9	41.2	43.55	10.8%
	Potassium	860	990	925	14.1%
	Sodium	577	500	538.5	14.3%
	Vanadium	32.1	30.6	31.35	4.8%
	Zinc	1400	1100	1250	24.0%
TCL BNA	Butyl benzyl phthalate	< 3.00	0.600 K	ERR	ERR
TCL Pest	Endosulfan,B	0.047	0.055	0.051	15.7%
	Endrin Aldehyde	0.062	0.069	0.0655	10.7%
	Methoxychlor	0.217	0.230	0.2235	5.8%
	P,P-DDD	0.059	0.058	0.0585	1.7%
	P,P-DDE	0.013	0.038	0.0255	98.0%
	P,P-DDT	0.480	0.510	0.495	6.1%
	PCB-1260	1.90	2.20	2.05	14.6%
TCL Pest	alpha-Chlordane	0.013	0.023	0.018	55.6%
	gamma-Chlordane	0.051	0.058	0.0545	12.8%
TOC	Total Organic Carbon	38600	42600	40600	9.9%
TPHC	Total Petroleum Hydrocarbons	960	920	940	4.3%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

Date: 03/15/94 | Table: F-5
File Type: CSO | Chemical Summary Report For Subsurface Soils
Site Type: BORE | Area of Contamination: P31
Units: UGG

Test	Parameter	Site ID	E3-P31-B01	E3-P31-B01		
		Field Sample ID	EDP31012	EXP31012		
		Sample Date	09/24/93	09/24/93		
Test	Parameter	Depth	4.5 ft.	4.5 ft.	Mean	RPD
TAL METAL	Aluminum		2860	5170	4015	57.5%
	Antimony		0.257	< 0.500	ERR	ERR
	Arsenic		6.46	6.87	6.665	6.2%
	Barium		8.87	13.9	11.385	44.2%
	Beryllium		0.190	0.267	0.2285	33.7%
	Calcium		176	171	173.5	2.9%
	Chromium		3.73	7.83	5.78	70.9%
	Cobalt		2.99	4.57	3.78	41.8%
	Copper		3.74	6.03	4.885	46.9%
	Iron		2980	5530	4255	59.9%
	Lead		5.98 F	6.22 F	ERR	ERR
	Magnesium		468	992	730	71.8%
	Manganese		82.9	129	105.95	43.5%
	Nickel		3.38	7.52	5.45	76.0%
	Potassium		321 X	417 X	ERR	ERR
	Vanadium		5.19	9.05	7.12	54.2%
	Zinc		13.4 X	19.4 X	ERR	ERR
TCL Pest	Endosulfan Sulfate		0.003	0.003	0.003	0.0%
	Endosulfan,B		< 0.002	0.005 K	ERR	ERR
	Methoxychlor		0.035	< 0.020	ERR	ERR
	P,P-DDD		0.003 B	0.006 K	ERR	ERR
	P,P-DDE		0.003 B	0.006 K	ERR	ERR
	P,P-DDT		0.006	0.007	0.0065	15.4%
	alpha-BHC		0.001	0.002	0.0015	66.7%
	beta-BHC		0.001	0.001	0.001	0.0%
	delta-BHC		0.000	< 0.002	ERR	ERR
TPHC	Total Petroleum Hydrocarbons		< 20.0	11.4	ERR	ERR

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: BORE

Table: F-5
Chemical Summary Report For Subsurface Soils
Area of Contamination: P37
Units: UGG

	Site ID	E3-P37-B03	E3-P37-B03		
	Field Sample ID	BD370302	BX370302		
	Sample Date	08/16/93	08/16/93		
Test	Parameter Depth	14.0 ft.	14.0 ft.	Mean	RPD
TAL METAL	Aluminum	6940	6620	6780	4.7%
	Arsenic	5.47	6.98	6.225	24.3%
	Barium	35.5	27.6	31.55	25.0%
	Beryllium	0.306	0.327	0.3165	6.6%
	Calcium	1190	975	1082.5	19.9%
	Chromium	16.0	13.6	14.8	16.2%
	Cobalt	8.02	6.74	7.38	17.3%
	Copper	9.56	8.70	9.13	9.4%
	Iron	12000	11500	11750	4.3%
	Lead	2.99 F	3.77 F	ERR	ERR
	Magnesium	2730	2550	2640	6.8%
	Manganese	151	129	140	15.7%
	Nickel	21.8	17.7	19.75	20.8%
	Potassium	1530	1460	1495	4.7%
	Vanadium	16.7	15.0	15.85	10.7%
	Zinc	41.7	35.6	38.65	15.8%
TCL BNA	Bis(2-ethylhexyl)phthalate	0.110 F	< 0.330	ERR	ERR
	Di-n-octyl phthalate	0.028	< 0.330	ERR	ERR
TOC	Total Organic Carbon	2070	3770	2920	58.2%
TPHC	Total Petroleum Hydrocarbons	< 20.0	13.2	ERR	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSO
Site Type: BORE

Table: F-5
Chemical Summary Report For Subsurface Soils
Area of Contamination: P01
Units: UGG

	Site ID	E3-P01-B03	E3-P01-B03		
	Field Sample ID	BD010302	BX010302		
	Sample Date	08/13/93	08/13/93		
Test	Parameter Depth	9.0 ft.	9.0 ft.	Mean	RPD
TPHC	Total Petroleum Hydrocarbons	23.9	24.3	24.1	1.7%

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSW
Site Type: POND

Table: F-5
Chemical Summary Report For Surface Waters
Area of Contamination: P11
Units: UGL

	Site ID	E3-P11-D01	E3-P11-D01		
	Field Sample ID	WDP11012	WXP11012		
	Sample Date	12/01/93	12/01/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	4090	2910	3500	33.7%
	Arsenic	1.57	1.94	1.755	21.1%
	Barium	78.3	52.3	65.3	39.8%
	Beryllium	0.288	0.217	0.2525	28.1%
	Calcium	8430	7210	7820	15.6%
	Chromium	3.89	< 10.0	ERR	ERR
	Cobalt	3.10	3.18	3.14	2.5%
	Copper	10.5	7.22	8.86	37.0%
	Iron	2800	1830	2315	41.9%
	Lead	21.6	13.0	17.3	49.7%
	Magnesium	1710	1640	1675	4.2%
	Manganese	544	515	529.5	5.5%
	Vanadium	10.1	5.64	7.87	56.7%
	Zinc	82.7	65.7	74.2	22.9%
TCL BNA	2,4,6-Tribromophenyl	48.0	67.0	57.5	33.0%
	2-Fluorobiphenyl	78.0	71.0	74.5	9.4%
	2-Fluorophenol	38.0	47.0	42.5	21.2%
	Nitrobenzene - d5	67.0	65.0	66	3.0%
	PHEND5	29.0	34.0	31.5	15.9%
	Terphenyl - d14	100	98.0	99	2.0%
TCL Pest	DBUCLE	2.10	2.20	2.15	4.7%
	Isodrin	0.440	0.480	0.46	8.7%
TCL VOA	Acetone	< 10.0	12.0	ERR	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94	Table: F-5
File Type: CSW	Chemical Summary Report For Surface Waters
Site Type: POND	Area of Contamination: FW
	Units: UGL

Test	Parameter	E3-BCK-D02	E3-BCK-D02	Mean	RPD
	Site ID	E3-BCK-D02	E3-BCK-D02		
	Field Sample ID	WDBCK021	WXBCK021		
	Sample Date	09/22/93	09/22/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	2-Amino-4,6-dinitrotoluene	21.8	27.4	24.6	22.8%
	3,4-Dinitrotoluene	6.35	6.58	6.465	3.6%
	Cyclonite	< 1.00	0.265	ERR	ERR
TAL METAL	Aluminum	833	328	580.5	87.0%
	Antimony	< 5.00	< 5.00	ERR	ERR
	Arsenic	4.18	2.56	3.37	48.1%
	Barium	15.3	13.7	14.5	11.0%
	Beryllium	< 5.00	< 5.00	ERR	ERR
	Cadmium	< 5.00	< 5.00	ERR	ERR
	Calcium	3920	3750	3835	4.4%
	Chromium	2.68	< 10.0	ERR	ERR
	Cobalt	3.05	< 10.0	ERR	ERR
	Copper	2.95	< 10.0	ERR	ERR
	Iron	2960	1500	2230	65.5%
	Lead	8.57	6.01	7.29	35.1%
	Magnesium	1380	1310	1345	5.2%
	Manganese	235	211	223	10.8%
	Nickel	< 10.0	< 10.0	ERR	ERR
	Potassium	1410	2140	1775	41.1%
	Silver	< 2.00	< 2.00	ERR	ERR
	Sodium	4440	4680	4560	5.3%
	Vanadium	4.86	< 10.0	ERR	ERR
	Zinc	53.0	44.1	48.55	18.3%
TCL BNA	2,4,6-Tribromophenyl	47.0	62.0	54.5	27.5%
	2-Fluorobiphenyl	62.0	64.0	63	3.2%
	2-Fluorophenol	34.0	44.0	39	25.6%
	Bis(2-ethylhexyl)phthalate	1.00	0.850	0.925	16.2%
TCL BNA	Hexadecanoic Acid	5.90		2.95	200.0%
	Nitrobenzene - d5	64.0	63.0	63.5	1.6%
	PHEND5	23.0	29.0	26	23.1%
	Terphenyl - d14	66.0	67.0	66.5	1.5%
TCL Pest	DBUCLE	2.40	2.40	2.4	0.0%
	Isodrin	0.380	0.360	0.37	5.4%
	beta-BHC	< 0.040	< 0.040	ERR	ERR
TCL VOA	12DCD4	57.0	53.0	55	7.3%
	4BFB	54.0	52.0	53	3.8%
	MEC6D8	47.0	47.0	47	0.0%
WQP	Phosphorus, Total	150	34.0	92	126.1%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSW
Site Type: POND

Table: F-5
Chemical Summary Report For Surface Waters
Area of Contamination: FW
Units: UGL

	Site ID	E3-PUF-D02	E3-PUF-D02		
	Field Sample ID	WDPUF021	WXPUF021		
	Sample Date	11/05/93	11/05/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	2-Amino-4,6-dinitrotoluene			0	ERR
	3,4-Dinitrotoluene			0	ERR
	Cyclonite			0	ERR
TAL METAL	Aluminum	42.8	548	295.4	171.0%
	Antimony	< 5.00	1.40	ERR	ERR
	Arsenic	2.83	1.81	2.32	44.0%
	Barium	< 10.0	209	ERR	ERR
	Beryllium	< 5.00	100	ERR	ERR
	Cadmium	3.06	99.7	51.38	188.1%
	Calcium	3730	13800	8765	114.9%
	Chromium	3.13	204	103.565	194.0%
	Cobalt	< 10.0	197	ERR	ERR
	Copper	< 10.0	193	ERR	ERR
	Iron	467	950	708.5	68.2%
	Lead	3.25	1.71	2.48	62.1%
	Magnesium	902	11000	5951	169.7%
	Manganese	17.7	117	67.35	147.4%
	Nickel	< 10.0	199	ERR	ERR
	Potassium	1110 B	21100	ERR	ERR
	Silver	< 2.00	40.0	ERR	ERR
	Sodium	6250	46100	26175	152.2%
	Vanadium	< 10.0	206	ERR	ERR
	Zinc	6.00 B	404	ERR	ERR
TCL BNA	2,4,6-Tribromophenyl			0	ERR
	2-Fluorobiphenyl			0	ERR
	2-Fluorophenol			0	ERR
	Bis(2-ethylhexyl)phthalate			0	ERR
TCL BNA	Hexadecanoic Acid			0	ERR
	Nitrobenzene - d5			0	ERR
	PHEND5			0	ERR
	Terphenyl - d14			0	ERR
TCL Pest	DBUCLE	1.70	1.60	1.65	6.1%
	Isodrin	0.320	0.320	0.32	0.0%
	beta-BHC	0.100	0.090	0.095	10.5%
TCL VOA	12DCD4			0	ERR
	4BFB			0	ERR
	MEC6D8			0	ERR
WQP	Phosphorus, Total			0	ERR

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CSW
Site Type: POND

Table: F-5
Chemical Summary Report For Surface Waters
Area of Contamination: P26
Units: UGL

	Site ID	E3-P26-D01		E3-P26-D01			
	Field Sample ID	WD2601X1		WX2601X1			
	. Sample Date	08/04/93		08/04/93			
Test	Parameter .					Mean	RPD
TAL METAL	Aluminum	322		443		382.5	31.6%
	Arsenic	8.00		8.89		8.445	10.5%
	Barium	9.32		11.2		10.26	18.3%
	Beryllium	0.148		0.173		0.1605	15.6%
	Calcium	5080		5110		5095	0.6%
	Copper	< 10.0		2.57		ERR	ERR
	Iron	1600		1900		1750	17.1%
	Magnesium	941		947		944	0.6%
	Manganese	337		345		341	2.3%
	Potassium	1840		1960		1900	6.3%
	Sodium	3670	K	3790	K	ERR	ERR
	Zinc	63.1		24.8	B	ERR	ERR
TCL BNA	2,4,6-Tribromophenyl	66.0		50.0		58	27.6%
	2-Fluorobiphenyl	94.0		79.0		86.5	17.3%
	2-Fluorophenol	37.0		27.0		32	31.3%
	Nitrobenzene - d5	71.0		59.0		65	18.5%
	PHEND5	24.0		17.0		20.5	34.1%
	Terphenyl - d14	87.0		76.0		81.5	13.5%
TCL Pest	DBUCLE	2.34		2.05		2.195	13.2%
	Isodrin	0.388		0.300		0.344	25.6%
TCL VOA	12DCD4	56.0		53.0		54.5	5.5%
	4BFB	37.0		39.0		38	5.3%
	MEC6D8	47.0		50.0		48.5	6.2%

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P31
Units: UGL

	Site ID	E3-P31-M01		E3-P31-M01			
	Field Sample ID	MDP31012		MXP31012			
	Sample Date	12/03/93		12/03/93			
Test	Parameter .					Mean	RPD
TAL METAL	Aluminum	4080		5910		4995	36.6%
	Antimony	< 5.00		1.44		ERR	ERR
	Arsenic	62.3		74.2		68.25	17.4%
	Barium	26.7		32.7		29.7	20.2%
	Beryllium	0.150		0.244		0.197	47.7%
	Calcium	3800		4030		3915	5.9%
	Chromium	5.16		8.55		6.855	49.5%
	Cobalt	16.5		17.5		17	5.9%
	Copper	8.64		9.26		8.95	6.9%
	Iron	18000		22000		20000	20.0%
	Lead	8.38		9.17		8.775	9.0%
	Magnesium	1830		2280		2055	21.9%
	Manganese	630		664		647	5.3%
	Nickel	11.9		13.0		12.45	8.8%
	Potassium	2100		2380		2240	12.5%
	Selenium	< 2.00		< 2.00		ERR	ERR
	Sodium	5570	X	5660	X	ERR	ERR
	Vanadium	8.95		11.6		10.275	25.8%
	Zinc	42.8		45.3		44.05	5.7%

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P31
Units: UGL

	Site ID	E3-P31-M01	E3-P31-M01		
	Field Sample ID	MFP31012	MHP31012		
	Sample Date	12/03/93	12/03/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	13.9 F	< 25.0	ERR	ERR
	Antimony	< 5.00	3.46 F	ERR	ERR
	Arsenic	63.4	70.3	66.85	10.3%
	Barium	16.6	13.2	14.9	22.8%
	Beryllium	< 5.00	< 5.00	ERR	ERR
	Calcium	4440	4410	4425	0.7%
	Chromium	< 10.0	< 10.0	ERR	ERR
	Cobalt	19.3	16.2	17.75	17.5%
	Copper	< 10.0	3.40	ERR	ERR
	Iron	24000	21000	22500	13.3%
	Lead	< 5.00	1.01	ERR	ERR
	Magnesium	1290	1310	1300	1.5%
	Manganese	734	716	725	2.5%
	Nickel	< 10.0	< 10.0	ERR	ERR
	Potassium	1620	1760	1690	8.3%
	Selenium	3.30	< 2.00	ERR	ERR
	Sodium	4380 F	4390 F	ERR	ERR
	Vanadium	4.61	3.48	4.045	27.9%
	Zinc	8.29 F	8.36 F	ERR	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column. U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94	Table: F-5
File Type: CGW	Chemical Summary Report For Groundwater
Site Type: WELL	Area of Contamination: P03
	Units: UGL

	Site ID	E3-P03-M01	E3-P03-M01		
	Field Sample ID	MDP03011	MXP03011		
	Sample Date	09/16/93	09/16/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	36000	35000	35500	2.8%
	Antimony	24.0	10.4	17.2	79.1%
	Arsenic	19.9	18.7	19.3	6.2%
	Barium	230	225	227.5	2.2%
	Beryllium	1.59	1.54	1.565	3.2%
	Cadmium	5.25	3.78	4.515	32.6%
	Calcium	12500	12200	12350	2.4%
	Chromium	72.0	72.1	72.05	0.1%
	Cobalt	31.3	31.6	31.45	1.0%
	Copper	56.5	53.0	54.75	6.4%
	Iron	45000	43000	44000	4.5%
	Lead	15.2	13.1	14.15	14.8%
	Magnesium	16400	16100	16250	1.8%
	Manganese	841	831	836	1.2%
	Nickel	62.9	59.7	61.3	5.2%
	Potassium	14700	14500	14600	1.4%
	Sodium	7840	8080	7960	3.0%
	Vanadium	94.2	91.4	92.8	3.0%
	Zinc	261	180	220.5	36.7%
TCL Pest	P,P-DDT	0.140 F	< 0.800	ERR	ERR
	alpha-BHC	0.280	0.720	0.5	88.0%

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94 File Type: CGW Site Type: WELL	Table: F-5 Chemical Summary Report For Groundwater Area of Contamination: P03 Units: UGL				
	Site ID	E3-P03-M01	E3-P03-M01		
	Field Sample ID	MFP03011	MHP03011		
	Sample Date	09/16/93	09/16/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	93.5 F	74.4 F	ERR	ERR
	Antimony	5.77 F	14.6 F	ERR	ERR
	Arsenic	5.03	5.08	5.055	1.0%
	Barium	8.50	7.64	8.07	10.7%
	Beryllium	< 5.00	< 5.00	ERR	ERR
	Cadmium	< 5.00	< 5.00	ERR	ERR
	Calcium	8550	8720	8635	2.0%
	Chromium	< 10.0	< 10.0	ERR	ERR
	Cobalt	< 10.0	< 10.0	ERR	ERR
	Copper	3.05	2.93	2.99	4.0%
	Iron	91.2 F	55.6 F	ERR	ERR
	Lead	< 5.00	< 5.00	ERR	ERR
	Magnesium	3690	3680	3685	0.3%
	Manganese	271	275	273	1.5%
	Nickel	< 10.0	< 10.0	ERR	ERR
	Potassium	3110	3010	3060	3.3%
	Sodium	6930	7410	7170	6.7%
	Vanadium	< 10.0	< 10.0	ERR	ERR
	Zinc	11.2 F	13.7 F	ERR	ERR
TCL Pest	P,P-DDT			0	ERR
	alpha-BHC			0	ERR

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc

C= Confirmed on second column. U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P58
Units: UGL

Test	Parameter	E3-P58-M01	E3-P58-M01	Mean	RPD
	Field Sample ID	MFP58011	MHP58011		
	Sample Date	09/02/93	09/02/93		
EXPLOSIVES	1,3-Dinitrobenzene			0	ERR
	3-Nitrotoluene			0	ERR
TAL METAL	Aluminum	69.8 BF	70.7 BF	ERR	ERR
	Antimony	6.93 F	< 5.00	ERR	ERR
	Arsenic	2.21	2.84	2.525	25.0%
	Barium	108	118	113	8.8%
	Beryllium	< 5.00	< 5.00	ERR	ERR
	Cadmium	< 5.00	< 5.00	ERR	ERR
	Calcium	5800	5720	5760	1.4%
	Chromium	7.80	< 10.0	ERR	ERR
	Cobalt	3.84	4.04	3.94	5.1%
	Copper	3.84	< 10.0	ERR	ERR
	Iron	9640	9960	9800	3.3%
	Lead	< 5.00	< 5.00	ERR	ERR
	Magnesium	1000	968	984	3.3%
	Manganese	737	739	738	0.3%
	Nickel	< 10.0	< 10.0	ERR	ERR
	Potassium	740	700	720	5.6%
	Sodium	4050	3930	3990	3.0%
	Vanadium	< 10.0	< 10.0	ERR	ERR
	Zinc	23.2 BF	19.1 BF	ERR	ERR
TCL Pest	Lindane			0	ERR
	P,P-DDE			0	ERR
	P,P-DDT			0	ERR
	alpha-BHC			0	ERR
	beta-BHC			0	ERR
WQP	Nitrate			0	ERR
	Phosphorus, Total			0	ERR

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P58
Units: UGL

	Site ID	E3-P58-M01	E3-P58-M01		
	Field Sample ID	MFP58012	MHP58012		
	Sample Date	12/02/93	12/02/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	1,3-Dinitrobenzene			0	ERR
	3-Nitrotoluene			0	ERR
TAL METAL	Aluminum	54.4 F	83.3 F	ERR	ERR
	Antimony	3.96 F	3.94 F	ERR	ERR
	Arsenic	< 2.00	< 2.00	ERR	ERR
	Barium	247	262	254.5	5.9%
	Beryllium	< 5.00	< 5.00	ERR	ERR
	Cadmium	< 5.00	< 5.00	ERR	ERR
	Calcium	6980	6810	6895	2.5%
	Chromium	< 10.0	< 10.0	ERR	ERR
	Cobalt	3.62	3.42	3.52	5.7%
	Copper	< 10.0	< 10.0	ERR	ERR
	Iron	14000	13000	13500	7.4%
	Lead	< 5.00	< 5.00	ERR	ERR
	Magnesium	1050	998	1024	5.1%
	Manganese	578	561	569.5	3.0%
	Nickel	< 10.0	8.32	ERR	ERR
	Potassium	939	861	900	8.7%
	Sodium	5720 X	6430 X	ERR	ERR
	Vanadium	3.63	4.89	4.26	29.6%
	Zinc	190	220	205	14.6%
TCL Pest	Lindane			0	ERR
	P,P-DDE			0	ERR
	P,P-DDT			0	ERR
	alpha-BHC			0	ERR
	beta-BHC			0	ERR
WQP	Nitrate			0	ERR
	Phosphorus, Total			0	ERR

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P58
Units: UGL

	Site ID	E3-P58-M01	E3-P58-M01		
	Field Sample ID	MDP58011	MXP58011		
	Sample Date	09/02/93	09/02/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	1,3-Dinitrobenzene	0.369 F	0.529 F	ERR	ERR
	3-Nitrotoluene	< 1.00	0.600 F	ERR	ERR
TAL METAL	Aluminum	22000	15000	18500	37.8%
	Antimony	< 5.00	< 5.00	ERR	ERR
	Arsenic	46.3	37.1	41.7	22.1%
	Barium	219	199	209	9.6%
	Beryllium	1.26	0.980	1.12	25.0%
	Cadmium	2.54	< 5.00	ERR	ERR
	Calcium	6640	6450	6545	2.9%
	Chromium	25.9	18.8	22.35	31.8%
	Cobalt	17.9	16.3	17.1	9.4%
	Copper	39.0	31.0	35	22.9%
	Iron	33000	26000	29500	23.7%
	Lead	30.5	23.0	26.75	28.0%
	Magnesium	4020	3260	3640	20.9%
	Manganese	942	864	903	8.6%
	Nickel	27.2	20.8	24	26.7%
	Potassium	2220	1930	2075	14.0%
	Sodium	4470	4310	4390	3.6%
	Vanadium	30.9	25.0	27.95	21.1%
	Zinc	141	128	134.5	9.7%
TCL Pest	Lindane	< 0.020	< 0.100	ERR	ERR
	P,P-DDE	0.028	< 0.200	ERR	ERR
	P,P-DDT	0.088 F	< 0.200	ERR	ERR
	alpha-BHC	0.025	0.160	0.0925	145.9%
	beta-BHC	0.050	< 0.100	ERR	ERR
WQP	Nitrate				
	Phosphorus, Total				

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

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J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94		Table: F-5			
File Type: CGW		Chemical Summary Report For Groundwater			
Site Type: WELL		Area of Contamination: P58			
		Units: UGL			
	Site ID	E3-P58-M01	E3-P58-M01		
	Field Sample ID	MXP58012	MDP58012		
	Sample Date	12/02/93	12/02/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	1,3-Dinitrobenzene	< 1.00	< 1.00	ERR	ERR
	3-Nitrotoluene	< 1.00	< 1.00	ERR	ERR
TAL METAL	Aluminum	4320	29000	16660	148.1%
	Antimony	< 5.00	< 5.00	ERR	ERR
	Arsenic	6.52	47.0	26.76	151.3%
	Barium	300	419	359.5	33.1%
	Beryllium	0.252	1.64	0.946	146.7%
	Cadmium	1.42	< 5.00	ERR	ERR
	Calcium	7490	8910	8200	17.3%
	Chromium	6.24	32.8	19.52	136.1%
	Cobalt	7.65	24.1	15.875	103.6%
	Copper	14.4	55.3	34.85	117.4%
	Iron	20000	53000	36500	90.4%
	Lead	4.96 K	43.4	ERR	ERR
	Magnesium	1860	5280	3570	95.8%
	Manganese	634	791	712.5	22.0%
	Nickel	11.4	37.9	24.65	107.5%
	Potassium	2060 B	3840 B	ERR	ERR
	Sodium	7640 K	8610 K	ERR	ERR
	Vanadium	9.36	40.5	24.93	124.9%
	Zinc	389	532	460.5	31.1%
TCL Pest	Lindane	< 0.025	0.023	ERR	ERR
	P,P-DDE	< 0.049	< 0.048	ERR	ERR
	P,P-DDT	< 0.049	0.065	ERR	ERR
	alpha-BHC	< 0.025	< 0.024	ERR	ERR
	beta-BHC	< 0.025	< 0.024	ERR	ERR
WQP	Nitrate	45.3	68.7	57	41.1%
WQP	Phosphorus, Total	36.0	1200	618	188.3%

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P36
Units: UGL

Test	Parameter	E3-P36-M02	E3-P36-M02	Mean	RPD
	Field Sample ID	MDP36021	MXP36021		
	Sample Date	09/02/93	09/02/93		
TAL METAL	Aluminum	3450	4050	3750	16.0%
	Antimony	< 5.00	2.07	ERR	ERR
	Arsenic	2.71	3.92	3.315	36.5%
	Barium	32.5	35.4	33.95	8.5%
	Calcium	2510	2450	2480	2.4%
	Chromium	7.44	6.71	7.075	10.3%
	Cobalt	2.82	4.47	3.645	45.3%
	Copper	5.38	8.04	6.71	39.6%
	Iron	4020	5040	4530	22.5%
	Lead	3.53	< 5.00	ERR	ERR
	Magnesium	1280	1460	1370	13.1%
	Manganese	153	155	154	1.3%
	Potassium	1980	2040	2010	3.0%
	Sodium	7250	6870	7060	5.4%
	Vanadium	6.98	10.4	8.69	39.4%
	Zinc	60.7 K	24.0 BF	ERR	ERR
TCL Pest	Lindane	0.021 F	< 0.020	ERR	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column. U= Unconfirmed.
J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P36
Units: UGL

	Site ID	E3-P36-M02	E3-P36-M02		
	Field Sample ID	MFP36021	MHP36021		
	Sample Date	09/02/93	09/02/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	24.2 BF	25.9 BF	ERR	ERR
	Antimony	< 5.00	8.73 F	ERR	ERR
	Arsenic	< 2.00	< 2.00	ERR	ERR
	Barium	5.36	4.73	5.045	12.5%
	Calcium	1970	2060	2015	4.5%
	Chromium	4.00	< 10.0	ERR	ERR
	Cobalt	< 10.0	< 10.0	ERR	ERR
	Copper	< 10.0	< 10.0	ERR	ERR
	Iron	21.8 F	< 25.0	ERR	ERR
	Lead	< 5.00	< 5.00	ERR	ERR
	Magnesium	486	493	489.5	1.4%
	Manganese	106	104	105	1.9%
	Potassium	1250	1220	1235	2.4%
	Sodium	7220	7140	7180	1.1%
	Vanadium	< 10.0	3.58	ERR	ERR
	Zinc	5.75 BF	18.7 BF	ERR	ERR
TCL Pest	Lindane				

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P37
Units: UGL

Test	Parameter	E3-P37-M01	E3-P37-M01	Mean	RPD
	Field Sample ID	MDP37011	MXP37011		
	Sample Date	09/02/93	09/02/93		
TAL METAL	Aluminum	12000	11000	11500	8.7%
	Antimony	1.81	2.70	2.255	39.5%
	Arsenic	34.5	29.2	31.85	16.6%
	Barium	62.1	74.8	68.45	18.6%
	Beryllium	0.475	0.547	0.511	14.1%
	Cadmium	< 5.00	1.35	ERR	ERR
	Calcium	4960	4990	4975	0.6%
	Chromium	16.3	19.1	17.7	15.8%
	Cobalt	18.4	16.1	17.25	13.3%
	Copper	160	14.2	87.1	167.4%
	Iron	1500	14000	7750	161.3%
	Lead	6.54	5.38	5.96	19.5%
	Magnesium	3580	3450	3515	3.7%
	Manganese	408	389	398.5	4.8%
	Nickel	< 10.0	17.3	ERR	ERR
	Potassium	2610	2520	2565	3.5%
	Sodium	4100	4140	4120	1.0%
	Vanadium	22.3	21.1	21.7	5.5%
	Zinc	113 X	144	ERR	ERR
TCL Pest	Lindane	< 0.020	0.026 F	ERR	ERR
	alpha-BHC	< 0.020	0.037	ERR	ERR
TCL VOA	Carbon disulfide	< 5.00	3.00 F	ERR	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P37
Units: UGL

	Site ID	E3-P37-M01	E3-P37-M01		
	Field Sample ID	MFP37011	MHP37011		
	Sample Date	09/02/93	09/02/93		
Test	Parameter			Mean	RPD
TAL METAL	Aluminum	15.5 BF	20.8 BF	ERR	ERR
	Antimony	< 5.00	< 5.00	ERR	ERR
	Arsenic	< 2.00	< 2.00	ERR	ERR
	Barium	8.49	6.09	7.29	32.9%
	Beryllium	< 5.00	< 5.00	ERR	ERR
	Cadmium	< 5.00	< 5.00	ERR	ERR
	Calcium	4070	4060	4065	0.2%
	Chromium	< 10.0	< 10.0	ERR	ERR
	Cobalt	< 10.0	< 10.0	ERR	ERR
	Copper	< 10.0	< 10.0	ERR	ERR
	Iron	< 25.0	< 25.0	ERR	ERR
	Lead	< 5.00	< 5.00	ERR	ERR
	Magnesium	658	720	689	9.0%
	Manganese	24.4	24.1	24.25	1.2%
	Nickel	< 10.0	< 10.0	ERR	ERR
	Potassium	647	726	686.5	11.5%
	Sodium	3780	3810	3795	0.8%
	Vanadium	< 10.0	< 10.0	ERR	ERR
	Zinc	65.7 K	78.5 K	ERR	ERR
TCL Pest	Lindane			0	ERR
	alpha-BHC			0	ERR
TCL VOA	Carbon disulfide			0	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P22
Units: UGL

	Site ID	E3-P22-M01	E3-P22-M01		
	Field Sample ID	MDP22011	MXP22011		
	Sample Date	08/31/93	08/31/93		
Test	Parameter .			Mean	RPD
EXPLOSIVES	1,3-Dinitrobenzene	0.335 F	0.278 F	ERR	ERR
	3-Nitrotoluene	1.22 F	1.06 F	ERR	ERR
TAL METAL	Aluminum	913	840	876.5	8.3%
	Antimony	< 5.00	< 5.00	ERR	ERR
	Arsenic	1.62	< 2.00	ERR	ERR
	Barium	22.3	24.5	23.4	9.4%
	Calcium	2850	2600	2725	9.2%
	Iron	506	491	498.5	3.0%
	Magnesium	735	704	719.5	4.3%
	Manganese	32.3	31.6	31.95	2.2%
	Nickel	9.58	< 10.0	ERR	ERR
	Potassium	862	885	873.5	2.6%
	Sodium	3630	3440	3535	5.4%
TCL Pest	alpha-BHC	< 0.100	0.170	ERR	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P22
Units: UGL

	Site ID	E3-P22-M01		E3-P22-M01			
	Field Sample ID	MFP22011		MHP22011			
	Sample Date	08/31/93		08/31/93			
Test	Parameter .					Mean	RPD
EXPLOSIVES	1,3-Dinitrobenzene					0	ERR
	3-Nitrotoluene					0	ERR
TAL METAL	Aluminum	27.4	F	60.6	F	ERR	ERR
	Antimony	5.05	F	< 5.00		ERR	ERR
	Arsenic	< 2.00		< 2.00		ERR	ERR
	Barium	6.80		6.32		6.56	7.3%
	Calcium	1850		1900		1875	2.7%
	Iron	< 25.0		29.0	F	ERR	ERR
	Magnesium	449		427		438	5.0%
	Manganese	20.8		21.1		20.95	1.4%
	Nickel	< 10.0		< 10.0		ERR	ERR
	Potassium	827		920		873.5	10.6%
	Sodium	3490		3300		3395	5.6%
TCL Pest	alpha-BHC					0	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P11
Units: UGL

	Site ID	E3-P11-M01		E3-P11-M01			
	Field Sample ID	MD1101F1		MF1101X1			
	Sample Date	08/24/93		08/24/93			
Test	Parameter .					Mean	RPD
TAL METAL	Aluminum	14.8	BF	14.7	BF	ERR	ERR
	Antimony	2.46	F	4.11	F	ERR	ERR
	Arsenic	< 2.00		< 2.00		ERR	ERR
	Barium	8.52		8.79		8.655	3.1%
	Beryllium	< 5.00		< 5.00		ERR	ERR
	Cadmium	< 5.00		< 5.00		ERR	ERR
	Calcium	6120		6140		6130	0.3%
	Chromium	5.34		< 10.0		ERR	ERR
	Cobalt	< 10.0		4.62		ERR	ERR
	Copper	< 10.0		< 10.0		ERR	ERR
	Iron	22.3	F	26.9	F	ERR	ERR
	Lead	< 5.00		< 5.00		ERR	ERR
	Magnesium	1060		1090		1075	2.8%
	Manganese	212		212		212	0.0%
	Nickel	< 10.0		< 10.0		ERR	ERR
	Potassium	3010		3080		3045	2.3%
	Sodium	3330		3370		3350	1.2%
	Vanadium	< 10.0		< 10.0		ERR	ERR
	Zinc	14.7	BF	17.9	K	ERR	ERR
TCL Pest	Endosulfan,A					0	ERR
TPHC	Total Petroleum Hydrocarbons					0	ERR

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low. @= Exc
K= Result bias high. R= Result rejected. != Excee

Date: 03/15/94
File Type: CGW
Site Type: WELL

Table: F-5
Chemical Summary Report For Groundwater
Area of Contamination: P11
Units: UGL

	Site ID	E3-P11-M01	E3-P11-M01		
	Field Sample ID	MD1101X1	MX1101X1		
	Sample Date	08/24/93	08/24/93		
Test	Parameter .			Mean	RPD
TAL METAL	Aluminum	37000	31000	34000	17.6%
	Antimony	< 5.00	2.36	ERR	ERR
	Arsenic	8.49	5.91	7.2	35.8%
	Barium	177	164	170.5	7.6%
	Beryllium	1.71	1.51	1.61	12.4%
	Cadmium	4.14	2.66	3.4	43.5%
	Calcium	11500	10600	11050	8.1%
	Chromium	67.8	61.0	64.4	10.6%
	Cobalt	28.4	24.3	26.35	15.6%
	Copper	48.3	42.4	45.35	13.0%
	Iron	41000	34000	37500	18.7%
	Lead	17.1	13.8	15.45	21.4%
	Magnesium	12500	10700	11600	15.5%
	Manganese	621	556	588.5	11.0%
	Nickel	70.6	52.5	61.55	29.4%
	Potassium	10900	9770	10335	10.9%
	Sodium	4700	4410	4555	6.4%
	Vanadium	74.9	64.8	69.85	14.5%
	Zinc	120 X	99.6 X	ERR	ERR
TCL Pest	Endosulfan,A	0.024	< 0.155	ERR	ERR
TPHC	Total Petroleum Hydrocarbons	< 2000	187	ERR	ERR

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. @= Exc
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. != Excee

Table F-6 Matrix Spike Data

Study Area A02

Field no:SX0201X1 Medium:CSO

Test	Lab	Lot	Analyte		Native	Spike 1		Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
TAL METAL	EL	AAKQ	AS		16.60600	0.00000		13.11000	4.00000	16.60600	0.0	0.0	0.0
TAL METAL	EL	AAKR	AG	LT	0.17480	0.00000	LT	0.17480	4.00000	2.49964	0.0	62.5	0.0
TAL METAL	EL	AAKR	BE		0.40379	0.00000		0.40291	10.00000	10.31320	0.0	99.1	0.0
TAL METAL	EL	AAKR	CD	LT	0.43700	0.00000	LT	0.43700	10.00000	9.43920	0.0	94.4	0.0
TAL METAL	EL	AAKR	CO		4.43992	0.00000		4.66716	20.00000	23.33580	0.0	94.5	0.0
TAL METAL	EL	AAKR	CR		11.79900	0.00000		11.01240	40.00000	50.34240	0.0	96.4	0.0
TAL METAL	EL	AAKR	CU		9.87620	0.00000		9.96360	20.00000	29.62860	0.0	98.8	0.0
TAL METAL	EL	AAKR	NI		8.48654	0.00000		8.04954	20.00000	27.00660	0.0	92.6	0.0
TAL METAL	EL	AAKR	V		15.29500	0.00000		15.03280	40.00000	55.76120	0.0	101.2	0.0
TAL METAL	EL	AAKR	ZN		23.51060	0.00000		18.96580	40.00000	56.11080	0.0	81.5	0.0
TAL METAL	EL	AALI	HG	LT	0.08740	0.00000	LT	0.08740	2.00000	1.53824	0.0	76.9	0.0
TAL METAL	EL	AALK	PB		6.78224	0.00000		6.45012	8.00000	11.36200	0.0	57.2	0.0
TAL METAL	EL	AALL	SB		0.86002	0.00000		0.78136	8.00000	3.06774	0.0	27.6	0.0
TAL METAL	EL	AALM	SE		0.23773	0.00000		0.37058	4.00000	3.07648	0.0	71.0	0.0
TAL METAL	EL	AALN	TL	LT	0.43700	0.00000	LT	0.43700	8.00000	6.15296	0.0	76.9	0.0
TCL BNA	EL	AAKM	124TCB	LT	0.28842	2.50000		1.22360	2.50000	1.57320	48.9	62.9	25.0
TCL BNA	EL	AAKM	14DCLB	LT	0.28842	2.50000		0.84778	2.50000	1.39840	33.9	55.9	49.0
TCL BNA	EL	AAKM	24DNT	LT	0.28842	2.50000		1.39840	2.50000	1.48580	55.9	59.4	6.1
TCL BNA	EL	AAKM	2CLP	LT	0.28842	3.33000		2.01020	3.33000	2.09760	60.4	63.0	4.2
TCL BNA	EL	AAKM	4CL3C	LT	0.28842	3.33000		2.18500	3.33000	2.09760	65.6	63.0	4.0
TCL BNA	EL	AAKM	4NP	LT	0.57684	3.33000		2.09760	3.33000	2.35980	63.0	70.9	11.8
TCL BNA	EL	AAKM	ANAPNE	LT	0.28842	2.50000		1.57320	2.50000	1.66060	62.9	66.4	5.4
TCL BNA	EL	AAKM	NNDNPA	LT	0.28842	2.50000		1.74800	2.50000	1.92280	69.9	76.9	9.5
TCL BNA	EL	AAKM	PCP	LT	0.57684	3.33000		2.18500	3.33000	2.35980	65.6	70.9	7.8
TCL BNA	EL	AAKM	PHENOL	LT	0.28842	3.33000		2.18500	3.33000	2.18500	65.6	65.6	0.0
TCL BNA	EL	AAKM	PYR	LT	0.28842	2.50000		1.83540	2.50000	1.66060	73.4	66.4	10.0
TCL Pest	EL	AAKL	AENSLF		0.00087	0.01300		0.01486	0.01300	0.01224	107.6	87.5	20.6
TCL Pest	EL	AAKL	ALDRN	LT	0.00087	0.01300		0.01835	0.01300	0.01573	141.2	121.0	15.4
TCL Pest	EL	AAKL	DLDRN	LT	0.00175	0.02700		0.04894	0.02700	0.04283	181.3	158.6	13.4
TCL Pest	EL	AAKL	ENDRN	LT	0.00175	0.02700		0.04632	0.02700	0.03846	171.6	142.4	18.6
TCL Pest	EL	AAKL	HPCL	LT	0.00087	0.01300		0.01748	0.01300	0.01486	134.5	114.3	16.2
TCL Pest	EL	AAKL	LIN	LT	0.00087	0.01300		0.01835	0.01300	0.01486	141.2	114.3	21.0
TCL Pest	EL	AAKL	MEXCLR	LT	0.00699	0.13300		0.17917	0.13300	0.15382	134.7	115.7	15.2
TCL Pest	EL	AAKL	PPDDT		0.00699	0.02700		0.04982	0.02700	0.04370	158.6	136.0	15.3
TCL VOA	EL	AAJY	11DCE	LT	0.00437	0.05000		0.04982	0.05000	0.05506	99.6	110.1	10.0
TCL VOA	EL	AAJY	C6H6	LT	0.00437	0.05000		0.04894	0.05000	0.05069	97.9	101.4	3.5

Table F-6 Matrix Spike Data

Study Area A02

Field no:SX0201X1 Medium:CSO

Test	Lab	Lot	Analyte	Native		Spike 1	Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
TCL VOA	EL	AAJY	CLC6H5	LT	0.00437	0.05000	0.04894	0.05000	0.04982	97.9	99.6	1.7
TCL VOA	EL	AAJY	MEC6H5	LT	0.00437	0.05000	0.05331	0.05000	0.05506	106.6	110.1	3.2
TCL VOA	EL	AAJY	TRCLE	LT	0.00437	0.05000	0.04807	0.05000	0.04894	96.1	97.9	1.9

Field no:SX0204X1 Medium:CSO

Test	Lab	Lot	Analyte	Native		Spike 1	Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
TPHC	EL	AARH	TPHC	LT	19.06000	0.00000	0.00000	337.00000	320.20800	0.0	95.0	0.0

Table F-6 Matrix Spike Data

Study Area A05

Field no:DXA05011 Medium:CSE

Test	Lab	Lot	Analyte		Native	Spike 1		Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
TAL METAL	EL	AAZO	AS		0.22792	0.00000		0.39308	4.00000	4.05760	0.0	95.7	0.0
TAL METAL	EL	ABBI	AG	LT	0.06340	0.00000	LT	0.06340	4.00000	3.74060	0.0	93.5	0.0
TAL METAL	EL	ABBI	BE	LT	0.15850	0.00000	LT	0.15850	10.00000	9.66850	0.0	96.7	0.0
TAL METAL	EL	ABBI	CD	LT	0.15850	0.00000	LT	0.15850	10.00000	9.63680	0.0	96.4	0.0
TAL METAL	EL	ABBI	CO	LT	0.31700	0.00000	LT	0.31700	20.00000	19.11510	0.0	95.6	0.0
TAL METAL	EL	ABBI	CR		1.33140	0.00000		1.03976	40.00000	40.25900	0.0	97.3	0.0
TAL METAL	EL	ABBI	CU		2.02880	0.00000		1.46137	20.00000	20.70010	0.0	93.4	0.0
TAL METAL	EL	ABBI	NI		0.98270	0.00000	LT	0.31700	20.00000	19.59060	0.0	93.0	0.0
TAL METAL	EL	ABBI	V		2.32995	0.00000		1.67059	40.00000	42.47800	0.0	100.4	0.0
TAL METAL	EL	ABBI	ZN		25.39170	0.00000		13.59930	40.00000	56.42600	0.0	77.6	0.0
TAL METAL	EL	ABBL	HG	LT	0.03170	0.00000	LT	0.03170	2.00000	1.42967	0.0	71.5	0.0
TAL METAL	EL	ABCC	PB		7.10080	0.00000		7.67140	8.00000	13.94800	0.0	85.6	0.0
TAL METAL	EL	ABCD	SB	LT	0.15850	0.00000	LT	0.15850	8.00000	6.14980	0.0	76.9	0.0
TAL METAL	EL	ABCE	SE	LT	0.06340	0.00000	LT	0.06340	4.00000	3.64550	0.0	91.1	0.0
TAL METAL	EL	ABCF	TL	LT	0.15850	0.00000	LT	0.15850	8.00000	7.16420	0.0	89.6	0.0
TCL Pest	UB	AEUC	ACLDAN		0.00098	0.04000		0.04410	0.04000	0.04371	107.8	106.8	0.9
TCL Pest	UB	AEUC	AENSLF		0.00118	0.04000		0.04077	0.04000	0.04096	99.0	99.5	0.5
TCL Pest	UB	AEUC	ALDRN		0.00039	0.04000		0.04488	0.04000	0.04508	111.2	111.7	0.4
TCL Pest	UB	AEUC	DLDRN		0.00137	0.04000		0.04626	0.04000	0.04645	112.2	112.7	0.4
TCL Pest	UB	AEUC	ENDRN		0.00431	0.04000		0.05429	0.04000	0.05566	125.0	128.4	2.7
TCL Pest	UB	AEUC	HPCL	LT	0.00039	0.04000		0.04704	0.04000	0.04684	117.6	117.1	0.4
TCL Pest	UB	AEUC	LIN		0.00216	0.04000		0.04567	0.04000	0.04626	108.8	110.3	1.4
TCL Pest	UB	AEUC	MEXCLR		0.01764	0.40000		0.49980	0.40000	0.48020	120.5	115.6	4.1
TCL Pest	UB	AEUC	PCB016	LT	0.00392	0.80000		0.68208	0.80000	0.71344	85.3	89.2	4.5
TCL Pest	UB	AEUC	PCB260	LT	0.00392	0.80000		0.79576	0.80000	0.90356	99.5	112.9	12.6
TCL Pest	UB	AEUC	PPDDT		0.00784	0.04000		0.05508	0.04000	0.05468	118.1	117.1	0.9

Field no:WXA05011 Medium:CSW

Test	Lab	Lot	Analyte		Native	Spike 1		Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
TAL METAL	EL	AAZS	AG	LT	2.00000	0.00000	LT	2.00000	40.00000	35.40000	0.0	88.5	0.0
TAL METAL	EL	AAZS	AL		918.00000	0.00000		1000.00000	500.00000	1660.00000	0.0	148.4	0.0
TAL METAL	EL	AAZS	BA		17.40000	0.00000		15.80000	200.00000	194.00000	0.0	88.3	0.0
TAL METAL	EL	AAZS	BE	LT	5.00000	0.00000	LT	5.00000	100.00000	92.20000	0.0	92.2	0.0
TAL METAL	EL	AAZS	CA		2220.00000	0.00000		2160.00000	10000.00000	11500.00000	0.0	92.8	0.0
TAL METAL	EL	AAZS	CD	LT	5.00000	0.00000	LT	5.00000	100.00000	89.30000	0.0	89.3	0.0

Table F-6 Matrix Spike Data

Study Area A05

Field no:WXA05011 Medium:CSW

Test	Lab	Lot	Analyte	Native		Spike 1		Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
TAL METAL	EL	AAZS	CO	LT	10.00000	0.00000	LT	10.00000	200.00000	181.00000	0.0	90.5	0.0
TAL METAL	EL	AAZS	CR		3.00000	0.00000	LT	10.00000	200.00000	183.00000	0.0	90.0	0.0
TAL METAL	EL	AAZS	CU	LT	10.00000	0.00000	LT	10.00000	200.00000	191.00000	0.0	95.5	0.0
TAL METAL	EL	AAZS	FE		812.00000	0.00000		833.00000	500.00000	1360.00000	0.0	109.6	0.0
TAL METAL	EL	AAZS	K		787.00000	0.00000		1390.00000	20000.00000	20100.00000	0.0	96.6	0.0
TAL METAL	EL	AAZS	MG		851.00000	0.00000		830.00000	10000.00000	1080.00000	0.0	2.3	0.0
TAL METAL	EL	AAZS	MN		390.00000	0.00000		382.00000	100.00000	464.00000	0.0	74.0	0.0
TAL METAL	EL	AAZS	NA		606.00000	0.00000		1250.00000	40000.00000	41000.00000	0.0	101.0	0.0
TAL METAL	EL	AAZS	NI	LT	10.00000	0.00000	LT	10.00000	200.00000	186.00000	0.0	93.0	0.0
TAL METAL	EL	AAZS	V	LT	10.00000	0.00000		3.34000	200.00000	189.00000	0.0	94.5	0.0
TAL METAL	EL	AAZS	ZN		39.40000	0.00000		23.00000	400.00000	420.00000	0.0	95.2	0.0
TAL METAL	EL	ABBH	AS		0.90000	0.00000		1.45000	40.00000	44.50000	0.0	109.0	0.0
TAL METAL	EL	ABBN	HG	LT	0.20000	0.00000	LT	0.20000	4.00000	3.42000	0.0	85.5	0.0
TAL METAL	EL	ABBW	PB		9.05000	0.00000		80.70000	80.00000	90.90000	0.0	102.3	0.0
TAL METAL	EL	ABBX	SB	LT	5.00000	0.00000	LT	5.00000	80.00000	69.20000	0.0	86.5	0.0
TAL METAL	EL	ABBY	SE	LT	2.00000	0.00000	LT	2.00000	40.00000	31.10000	0.0	77.8	0.0
TAL METAL	EL	ABBZ	TL	LT	2.00000	0.00000	LT	2.00000	40.00000	39.20000	0.0	98.0	0.0
TCL Pest	EL	ABAD	AENSLF	LT	0.08000	0.40000		0.48000	0.40000	0.40000	120.0	100.0	18.2
TCL Pest	EL	ABAD	ALDRN	LT	0.08000	0.40000		0.56000	0.40000	0.48000	140.0	120.0	15.4
TCL Pest	EL	ABAD	DLDRN	LT	0.16000	0.80000		1.10000	0.80000	0.96000	137.5	120.0	13.6
TCL Pest	EL	ABAD	ENDRN	LT	0.16000	0.80000		1.10000	0.80000	1.00000	137.5	125.0	9.5
TCL Pest	EL	ABAD	HPCL	LT	0.08000	0.40000		0.56000	0.40000	0.56000	140.0	140.0	0.0
TCL Pest	EL	ABAD	LIN	LT	0.08000	0.40000		0.64000	0.40000	0.52000	160.0	130.0	20.7
TCL Pest	EL	ABAD	MEXCLR	LT	0.80000	4.00000		4.80000	4.00000	4.40000	120.0	110.0	8.7
TCL Pest	EL	ABAD	PPDDT	LT	0.16000	0.80000		1.10000	0.80000	0.92000	137.5	115.0	17.8

Table F-6 Matrix Spike Data

Study Area A06

Field no:MXA06011 Medium:CGW

Test	Lab	Lot	Analyte		Native	Spike 1		Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
WQP	EL	AASD	NO2	LT	100.00000	0.00000		0.00000	800.00000	696.00000	0.0	87.0	0.0
WQP	EL	AASD	NO3		272.00000	0.00000		0.00000	800.00000	945.00000	0.0	84.1	0.0

Field no:MXBKDAF1 Medium:CGW

Test	Lab	Lot	Analyte		Native	Spike 1		Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
WQP	EL	AAZF	NO2	LT	100.00000	0.00000		0.00000	800.00000	329.00000	0.0	41.1	0.0
WQP	EL	AAZF	NO3	LT	100.00000	0.00000		0.00000	800.00000	538.00000	0.0	67.3	0.0

Field no:SXA06011 Medium:CSO

Test	Lab	Lot	Analyte		Native	Spike 1		Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
EXPLOSIVES	EL	AAXU	135TNB	LT	0.84800	8.00000		7.42000	8.00000	7.75072	92.8	96.9	4.3
EXPLOSIVES	EL	AAXU	246TNT	LT	0.84800	8.00000		8.48000	8.00000	8.26800	106.0	103.4	2.5
EXPLOSIVES	EL	AAXU	24DNT	LT	0.84800	8.00000		7.42000	8.00000	7.27584	92.8	90.9	2.1
EXPLOSIVES	EL	AAXU	26DNT	LT	0.84800	8.00000		6.98752	8.00000	6.86880	87.3	85.9	1.6
EXPLOSIVES	EL	AAXU	2NT	LT	0.84800	8.00000		7.19104	8.00000	7.21648	89.9	90.2	0.3
EXPLOSIVES	EL	AAXU	NB	LT	0.84800	8.00000		7.20800	8.00000	7.07232	90.1	88.4	1.9
EXPLOSIVES	EL	AAXU	RDX	LT	0.84800	8.00000		7.64896	8.00000	7.01296	95.6	87.7	8.6
EXPLOSIVES	EL	AAXW	NG	LT	8.48000	80.00000		74.36960	80.00000	72.67360	93.0	90.8	2.4
EXPLOSIVES	EL	AAXW	PETN	LT	8.48000	80.00000		72.16480	80.00000	71.23200	90.2	89.0	1.3
TAL METAL	EL	AAZN	AS		7.14016	0.00000		9.15840	4.00000	127.20000	0.0	3001.5	0.0
TAL METAL	EL	AAZQ	AG	LT	0.16960	0.00000	LT	0.16960	4.00000	3.18000	0.0	79.5	0.0
TAL METAL	EL	AAZQ	BE		0.19504	0.00000		0.22811	10.00000	9.92160	0.0	97.3	0.0
TAL METAL	EL	AAZQ	CD		0.28662	0.00000		0.36973	10.00000	9.58240	0.0	93.0	0.0
TAL METAL	EL	AAZQ	CO		10.43040	0.00000		14.84000	20.00000	30.10400	0.0	98.4	0.0
TAL METAL	EL	AAZQ	CR		12.04160	0.00000		12.80480	40.00000	5.18976	0.0	-17.1	0.0
TAL METAL	EL	AAZQ	CU		186.56000	0.00000		152.64000	20.00000	169.60000	0.0	-84.8	0.0
TAL METAL	EL	AAZQ	NI		16.28160	0.00000		19.75840	20.00000	36.88800	0.0	103.0	0.0
TAL METAL	EL	AAZQ	V		12.97440	0.00000		13.05920	40.00000	53.33920	0.0	100.9	0.0
TAL METAL	EL	AAZQ	ZN		71.23200	0.00000		110.24000	40.00000	106.84800	0.0	89.0	0.0
TAL METAL	EL	AAZT	HG	LT	0.08480	0.00000	LT	0.08480	2.00000	1.99280	0.0	99.6	0.0
TAL METAL	EL	ABAP	PB		212.00000	0.00000		101.76000	8.00000	93.28000	0.0	-1484.0	0.0
TAL METAL	EL	ABAQ	SB		0.37312	0.00000		0.45877	8.00000	5.02016	0.0	58.1	0.0
TAL METAL	EL	ABAR	SE	LT	0.16960	0.00000	LT	0.16960	4.00000	1.38224	0.0	34.6	0.0
TAL METAL	EL	ABAS	TL	LT	0.42400	0.00000	LT	0.42400	8.00000	7.64048	0.0	95.5	0.0

Table F-6 Matrix Spike Data

Study Area A06

Field no:SXA06011 Medium:CSO

Test	Lab	Lot	Analyte	Native	Spike 1	Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
TCL Pest	UB	AEPJ	ACLDAN	0.00034	0.00400	0.00338	0.00400	0.00338	76.0	76.0	0.0
TCL Pest	UB	AEPJ	AENSLF	0.00084	0.00400	0.00422	0.00400	0.00338	84.5	63.5	28.4
TCL Pest	UB	AEPJ	ALDRN	LT 0.00169	0.00400	0.00506	0.00400	0.00422	126.5	105.5	18.1
TCL Pest	UB	AEPJ	DLDRN	0.01182	0.00400	0.01013	0.00400	0.01519	-42.3	84.2	602.4
TCL Pest	UB	AEPJ	ENDRN	LT 0.00169	0.00400	0.00591	0.00400	0.00760	147.8	190.0	25.0
TCL Pest	UB	AEPJ	HPCL	LT 0.00169	0.00400	0.00422	0.00400	0.00422	105.5	105.5	0.0
TCL Pest	UB	AEPJ	LIN	LT 0.00169	0.00400	0.00422	0.00400	0.00422	105.5	105.5	0.0
TCL Pest	UB	AEPJ	MEXCLR	LT 0.01688	0.04000	0.04304	0.04000	0.04558	107.6	114.0	5.8
TCL Pest	UB	AEPJ	PCB016	LT 0.01688	0.04000	0.04558	0.04000	0.04304	114.0	107.6	5.8
TCL Pest	UB	AEPJ	PCB260	LT 0.01688	0.04000	0.05486	0.04000	0.03882	137.2	97.1	34.2
TCL Pest	UB	AEPJ	PPDDT	0.00338	0.00400	0.01097	0.00400	0.01097	189.8	189.8	0.0

Table F-6 Matrix Spike Data

Study Area A10

Field no:MFA10012 Medium:CGW

Test	Lab	Lot	Analyte	Native		Spike 1		Found 1	Spike 2		Found 2	Rec 1	Rec 2	RPD
TAL METAL	EL	ABGS	AS	LT	2.00000	0.00000	LT	2.00000	40.00000		41.40000	0.0	103.5	0.0
TAL METAL	EL	ABGU	AG	LT	2.00000	0.00000	LT	2.00000	40.00000		37.80000	0.0	94.5	0.0
TAL METAL	EL	ABGU	AL		16.30000	0.00000		29.90000	500.00000		533.00000	0.0	103.3	0.0
TAL METAL	EL	ABGU	BA		15.30000	0.00000		16.70000	200.00000		219.00000	0.0	101.9	0.0
TAL METAL	EL	ABGU	BE		0.27100	0.00000		0.93100	100.00000		105.00000	0.0	104.7	0.0
TAL METAL	EL	ABGU	CA		4730.00000	0.00000		4860.00000	10000.00000		15700.00000	0.0	109.7	0.0
TAL METAL	EL	ABGU	CD		1.74000	0.00000		1.49000	100.00000		104.00000	0.0	102.3	0.0
TAL METAL	EL	ABGU	CO	LT	10.00000	0.00000	LT	10.00000	200.00000		201.00000	0.0	100.5	0.0
TAL METAL	EL	ABGU	CR	LT	10.00000	0.00000	LT	10.00000	200.00000		208.00000	0.0	104.0	0.0
TAL METAL	EL	ABGU	CU	LT	10.00000	0.00000	LT	10.00000	200.00000		200.00000	0.0	100.0	0.0
TAL METAL	EL	ABGU	FE	LT	25.00000	0.00000		25.90000	500.00000		527.00000	0.0	105.4	0.0
TAL METAL	EL	ABGU	K		829.00000	0.00000		930.00000	20000.00000		21700.00000	0.0	104.4	0.0
TAL METAL	EL	ABGU	MG		439.00000	0.00000		526.00000	10000.00000		11100.00000	0.0	106.6	0.0
TAL METAL	EL	ABGU	MN		13.90000	0.00000		14.80000	100.00000		115.00000	0.0	101.1	0.0
TAL METAL	EL	ABGU	NA		5180.00000	0.00000		5300.00000	40000.00000		47600.00000	0.0	106.1	0.0
TAL METAL	EL	ABGU	NI	LT	10.00000	0.00000	LT	10.00000	200.00000		201.00000	0.0	100.5	0.0
TAL METAL	EL	ABGU	V	LT	10.00000	0.00000	LT	10.00000	200.00000		211.00000	0.0	105.5	0.0
TAL METAL	EL	ABGU	ZN		9.15000	0.00000		10.50000	400.00000		421.00000	0.0	103.0	0.0
TAL METAL	EL	ABGW	HG	LT	0.20000	0.00000	LT	0.20000	4.00000	LT	0.20000	0.0	0.0	0.0
TAL METAL	EL	ABIH	PB	LT	5.00000	0.00000	LT	5.00000	80.00000		83.10000	0.0	103.9	0.0
TAL METAL	EL	ABII	SB		5.59000	0.00000		6.56000	80.00000		79.00000	0.0	91.8	0.0
TAL METAL	EL	ABIJ	SE	LT	2.00000	0.00000	LT	2.00000	40.00000		38.40000	0.0	96.0	0.0
TAL METAL	EL	ABIK	TL	LT	2.00000	0.00000	LT	2.00000	40.00000		39.60000	0.0	99.0	0.0

Field no:MXA10012 Medium:CGW

Test	Lab	Lot	Analyte	Native		Spike 1	Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
EXPLOSIVES	EL	ABGO	135TNB	LT	1.00000	8.00000	6.76000	8.00000	6.13000	84.5	76.6	9.8
EXPLOSIVES	EL	ABGO	246TNT	LT	1.00000	8.00000	7.34000	8.00000	7.07000	91.8	88.4	3.8
EXPLOSIVES	EL	ABGO	24DNT		0.25100	8.00000	6.93000	8.00000	6.77000	83.5	81.5	2.4
EXPLOSIVES	EL	ABGO	26DNT	LT	1.00000	8.00000	6.69000	8.00000	6.52000	83.6	81.5	2.5
EXPLOSIVES	EL	ABGO	2NT	LT	1.00000	8.00000	5.89000	8.00000	5.80000	73.6	72.5	1.5
EXPLOSIVES	EL	ABGO	NB	LT	1.00000	8.00000	5.60000	8.00000	5.50000	70.0	68.8	1.7
EXPLOSIVES	EL	ABGO	RDX	LT	1.00000	8.00000	7.08000	8.00000	6.94000	88.5	86.8	1.9
EXPLOSIVES	EL	ABGP	NG	LT	10.00000	80.00000	82.20000	80.00000	81.00000	102.8	101.3	1.5
EXPLOSIVES	EL	ABGP	PETN	LT	10.00000	80.00000	82.30000	80.00000	81.60000	102.9	102.0	0.9

Table F-6 Matrix Spike Data

Study Area A10

Field no:MXA10012 Medium:CGW

Test	Lab	Lot	Analyte		Native	Spike 1		Found 1	Spike 2		Found 2	Rec 1	Rec 2	RPD
TAL METAL	EL	ABGS	AS		110.00000	0.00000		120.00000	40.00000		160.00000	0.0	125.0	0.0
TAL METAL	EL	ABGU	AG	LT	2.00000	0.00000	LT	2.00000	40.00000		30.90000	0.0	77.3	0.0
TAL METAL	EL	ABGU	AL		68000.00000	0.00000		70000.00000	500.00000		71000.00000	0.0	600.0	0.0
TAL METAL	EL	ABGU	BA		189.00000	0.00000		192.00000	200.00000		386.00000	0.0	98.5	0.0
TAL METAL	EL	ABGU	BE		2.80000	0.00000		2.87000	100.00000		105.00000	0.0	102.2	0.0
TAL METAL	EL	ABGU	CA		8380.00000	0.00000		8530.00000	10000.00000		19000.00000	0.0	106.2	0.0
TAL METAL	EL	ABGU	CD	LT	5.00000	0.00000	LT	5.00000	100.00000		96.10000	0.0	96.1	0.0
TAL METAL	EL	ABGU	CO		45.20000	0.00000		45.00000	200.00000		238.00000	0.0	96.4	0.0
TAL METAL	EL	ABGU	CR		67.80000	0.00000		65.00000	200.00000		266.00000	0.0	99.1	0.0
TAL METAL	EL	ABGU	CU		73.20000	0.00000		73.20000	200.00000		263.00000	0.0	94.9	0.0
TAL METAL	EL	ABGU	FE		76000.00000	0.00000		77000.00000	500.00000		83000.00000	0.0	1400.0	0.0
TAL METAL	EL	ABGU	K		7060.00000	0.00000		7110.00000	20000.00000		27200.00000	0.0	100.7	0.0
TAL METAL	EL	ABGU	MG		9770.00000	0.00000		9910.00000	10000.00000		20700.00000	0.0	109.3	0.0
TAL METAL	EL	ABGU	MN		978.00000	0.00000		988.00000	100.00000		1080.00000	0.0	102.0	0.0
TAL METAL	EL	ABGU	NA		6700.00000	0.00000		6730.00000	40000.00000		47900.00000	0.0	103.0	0.0
TAL METAL	EL	ABGU	NI		60.10000	0.00000		63.40000	200.00000		257.00000	0.0	98.5	0.0
TAL METAL	EL	ABGU	V		77.50000	0.00000		79.20000	200.00000		285.00000	0.0	103.8	0.0
TAL METAL	EL	ABGU	ZN		167.00000	0.00000		116.00000	400.00000		495.00000	0.0	82.0	0.0
TAL METAL	EL	ABGW	HG	LT	0.20000	0.00000	LT	0.20000	4.00000	LT	0.20000	0.0	0.0	0.0
TAL METAL	EL	ABIH	PB		41.30000	0.00000		44.20000	80.00000		65.00000	0.0	29.6	0.0
TAL METAL	EL	ABII	SB		4.86000	0.00000		4.39000	80.00000		58.80000	0.0	67.4	0.0
TAL METAL	EL	ABIJ	SE	LT	2.00000	0.00000	LT	2.00000	40.00000		22.90000	0.0	57.3	0.0
TAL METAL	EL	ABIK	TL	LT	2.00000	0.00000	LT	2.00000	40.00000		44.40000	0.0	111.0	0.0

Field no:DX1001X1 Medium:CSE

Test	Lab	Lot	Analyte		Native	Spike 1	Found 1	Spike 2	Found 2	Rec 1	Rec 2	RPD
EXPLOSIVES	EL	AANK	135TNB	LT	1.00000	8.00000	6.92000	8.00000	6.82000	86.5	85.3	1.4
EXPLOSIVES	EL	AANK	246TNT	LT	1.00000	8.00000	8.09000	8.00000	7.80000	101.1	97.5	3.6
EXPLOSIVES	EL	AANK	24DNT	LT	1.00000	8.00000	6.68000	8.00000	6.55000	83.5	81.9	1.9
EXPLOSIVES	EL	AANK	26DNT	LT	1.00000	8.00000	6.58000	8.00000	6.45000	82.3	80.6	2.1
EXPLOSIVES	EL	AANK	2NT	LT	1.00000	8.00000	6.77000	8.00000	6.57000	84.6	82.1	3.0
EXPLOSIVES	EL	AANK	NB	LT	1.00000	8.00000	6.99000	8.00000	6.82000	87.4	85.3	2.4
EXPLOSIVES	EL	AANK	RDX	LT	1.00000	8.00000	7.07000	8.00000	6.81000	88.4	85.1	3.8
TAL METAL	EL	AAOH	AS		0.99000	0.00000	0.74580	4.00000	5.23050	0.0	106.0	0.0
TAL METAL	EL	AAOM	PB		2.65650	0.00000	2.62350	8.00000	11.10450	0.0	105.6	0.0

APPENDIX G

AQUIFER HYDRAULIC CHARACTERIZATION (SLUG TESTING)

APPENDIX G

AQUIFER HYDRAULIC CHARACTERIZATION (SLUG TESTING)

This is a technical report presenting the results of hydraulic conductivity tests conducted on Ecology and Environment, Inc. wells at the Sudbury Annex and a brief interpretation of the results. The text in Volume II provides further interpretation and manipulation of the data, to compare with results of previous results and help assess aquifer characteristics by watershed.

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SLUG TEST REPORT

G.1 INTRODUCTION

In 1993, the United States Army Environmental Center (USAEC) retained Ecology & Environment, Inc. (E & E) to conduct Remedial Investigations (RIs) and Site Investigations (SIs) at the Sudbury Annex Site, at Sudbury, Massachusetts.

As part of these activities at the Annex, E & E conducted hydraulic conductivity tests (slug testing) in wells installed during the summer of 1993. This report documents the results of the slug tests conducted for monitoring wells at various areas of concern at this site. Section G–2 describes the objectives of the tests, while Sections G-3 and G-4 detail the field methodology and data reduction and interpretation methodologies. The results of the tests are summarized in Section G-5, and conclusions and recommendations are presented in Section G–6. The raw data that resulted from the slug test are reproduced in Appendix A and Appendix B.

G.2 OBJECTIVES

E & E conducted (slug) tests in the new wells installed during the 1993 Field Investigation Activities at the Annex. The objectives of these tests were as follows:

- To determine the hydraulic conductivity of the water-bearing geological formations near and around the installed monitoring wells. The hydraulic conductivity of a formation will indicate the capacity for water conduction in each geological unit that is tested.

- To characterize and calculate the transmissivity of the water-bearing formations near and/or around the monitoring well screens. The transmissivity of an aquifer is the capacity of the aquifer to transmit water through a unit cross-sectional area of the formation.

- To help determine the rate of groundwater flow in tested areas.

- To help evaluate mass loading of the contaminant from the groundwater to the surface water bodies (if needed).

- To help estimate the transport rate of contaminants within the groundwater and from the groundwater to surface bodies, and adjacent streams at the sites (if needed).

G.3 FIELD METHODOLOGY

E & E conducted slug tests at the Annex using the Hermit 2000 electronic data logger and 10 and/or 20 pounds per square inch (PSI) transducers. The field methodology used for conducting the slug test at the Annex is described below.

Slugs of various sizes (2 feet and 5 feet in length with 1.25-inch, 1.50 inch, and 3.00-inch outside diameters (OD) were made from new PVC casing. The PVC slugs were filled with clean sand (commercial sand used for the well construction) and sealed at both ends.

E & E conducted both rising and falling head slug tests at each well. Both tests involved measurement of changes in water displacement caused by introduction of various slug sizes into each well. As the slug was lowered rapidly into a monitoring well, the water level rose in response. The water level then decreased as the well returned to equilibrium with the outside water level. The changes in the water level, with respect to time, were measured and recorded by the transducer and data logger. After the well had returned to its initial condition, the slug was rapidly removed causing an immediate drop in the water level. Measurements were again recorded as the water level returned to its original condition. E & E performed this procedure for each monitoring well tested during the 1993 slug testing activities at Fort Devens site.

OVA readings were taken before starting each test to determine if volatile organics from the well opening were possible health hazards. The total depth and depth to the water table were measured and recorded, and other data, pertinent to the tested well, were recorded on the slug test data sheet. Total depth and depth-to-water were measured using a weighted tape and an audible; electronic; water-level meter. These measurements were used to determine the length of the water column and to determine the appropriate slug length. A minimum of 3 to 4 feet of water was needed to run the slug test with a 2-foot slug.

Where possible and appropriate two or more monitoring wells were tested simultaneously. However, due to a locally fast well recovery, and distances between the wells (greater than 250 feet) most of the wells were tested individually.

Originally, a total of 27 newly installed monitoring wells were to be tested at the Annex. However, only 26 wells could be tested because well E3-A06-MO1 did not have sufficient water for testing. Table G-1 summarizes the slug test data and provides information on those monitoring wells tested.

Before running any tests, the scale factor, linearity, offset, and other transducer and test parameters were set on the data logger in accordance with the specifications provided by the data logger and transducers operations manual and transducer, to test single wells. If additional wells were tested simultaneously, E & E used subsequent input (e.g., 2, 3 ....) and

Table G-1

SLUG TEST DATA
SUDBURY, MASSACHUSETTS SITE

Well Number Format	Total Depth (TOC)[2]	Water Level (TOC)[2]	Slug Size Used (L/D)[1]	PVC Casing Diameter	Screen Interval	Top of Sandpack	Comments
E3-A02-MO1	20.27	13.58	2 feet 3 inches	4.00	8-18	6.0	
E3-A05-MO1	48.53	12.38	6 feet 1.25 inches	4.00	40-50	30.0	
E3-A10-MO1	20.82	14.82	5 feet 3 inches	4.00	8.5-18.5	5.5	
E3-PO2-MO1	21.03	15.35	6 feet 1.25 inches	4.00	8-18	5.6	
E3-PO3-MO1	61.64	39.28	2 feet 3 inches	2.00	44-54	44.0	
E3-P03-MO2	16.93	11.83	5 feet 3 inches	4.00	7.5-15	6.0	
E3-P11-MO1	18.21	9.44	2 feet 3 inches	4.00	6-16	4.0	
E3-P13-MO1	20.46	14.51	5 feet 3 inches	4.00	9-19	7.0	
E3-P13-MO2	19.91	5.73	2 feet 3 inches	4.00	8-18	6.0	
E3-P13-M03	18.66	7.67	5 feet 3 inches	4.00	8-18	6.0	
E3-P13-MO4	20.16	8.73	5 feet 3 inches	4.00	8.6-18.6	6.6	
E3-P22-MO1	19.91	7.49	6 feet 2.50 inches	4.00	8-18	6.0	
E3-P23-MO2	21.18	14.44	6 feet 1.25 inches	4.00	9.6-10.6	7.6	
E3-P26-MO1	21.80	8.63	6 feet 2.50 inches	4.00	8-18	6.0	
E3-P26-MO2	20.57	8.05	5 feet 3 inches	4.00	9-19	6.0	
E3-P26-MO3	20.21	8.48	6 feet 2.50 inches	4.00	8-18	6.5	
E3-P31-MO1	20.09	9.38	5 feet 3 inches	4.00	8-18	6.0	
E3-P36-MO1	19.50	17.01	2 feet 3 inches	4.00	8-18	6.0	
E3-P36-MO2	20.80	15.60	6 feet 1.25 inches	4.00	8-18	6.0	
E3-P36-MO3	21.18	16.68	2 feet 3 inches	4.00	9-19	7.0	
E3-P37-MO1	21.14	13.95	6 feet 2.50 inches	4.00	9-19	7.5	
E3-P37-MO2	20.85	16.32	2 feet 3 inches	4.00	9-19	7.5	
E3-P37-MO3	21.82	16.93	2 feet 3 inches	4.00	10-20	8.0	
E3-P57-MO1	20.82	12.34		4.00	9-19	6.5	
E3-P58-MO1	19.74	9.97		4.00	39-49	3.4	
E3-P58-MO2	50.21	8.6		4.00	8-18	6.0	

[1]L = Length of Slug (in feet); D = Outside Diameter of slug (in inches)
[2]TOC = Top of Casing

11:UC6010-1/RC1134_V3_03/14/94-D1

set corresponding parameters as Input 2.3. Once all the parameters are set, they do not need to be reset between tests. After the head reference is set, the data logger is ready to record data.

E & E rinsed all tapes, transducers, slugs and meters with water from the USAEC approved source before and after placement and at the time of slug removal from the monitoring well. In shallow wells, the transducer probe(s), were lowered to the bottom of the monitoring well and then raised a minimum of several inches to avoid interferences from potential sediment. In deep wells the transducer probe was lowered 2 to 10 feet below the bottom of the slug. Before testing each well, E & E carefully measured the rope connected to the slug to a length that allowed the slug to be completely submerged while allowing enough room for the transducer probe below the slug.

At each well location, the test number was entered into the data logger and recorded on the slug test data sheet. The slug was then lowered into the well and was held above the water level. The data logger reference value was then set at zero (since E & E was interested only in changes in water depth). The water level, as read by the transducer, was checked to ensure that the water level was stable and the drawdown was zero. If for some reason the drawdown indicated some change, the reference was reset at zero. The slug was then lowered quickly but steadily into the water at the same time as the test was started on the data logger. The data logger then recorded the falling head data until the static level was reached or the water fell to within 10 percent of the initial elevation. The recovery time for the majority of the tested wells at Sudbury ranged from less than a minute to 1 hour or more.

After recording the head, drawdown, and time, E & E performed the rising head test. To start the rising head test, the slug was removed and simultaneously the data logger began recording. The rising head test was run as a step test and the data recorded as Step 1 rather than Step 0. This produced a separate data file for each falling and rising head test with both starting times as zero. After a minimum of 90 percent recovery to the initial water level, E & E recorded the drawdown and time and stopped the test.

G.4 DATA REDUCTION AND INTERPRETATION

E & E electronically transferred data collected in the field to a microcomputer for data reduction and interpretation. Because the data logger can only hold up to 10 tests, the recorded data was downloaded on a daily basis to the microcomputer. The data were stored on the hard drive and a backup copy was made on a diskette. After the data were downloaded, the hermit was reinitialized so that the data logger could be made available for further slug testing.

The following steps were used in data reduction:

- Checked data transferred from the Hermit disk and checked for corrections and completeness;

- Generated a second type of file which included only time and drawdown, to be used by the slug interpretation package (SLUGIX);

- Developed an in-house computer program to generate a printout of raw Hermit data files (Appendix G-A); and

- Imported Hermit data into the SLUGIX file for interpretation.

The data were interpreted using SLUGIX, a program written by Interpex in Denver, Colorado, designed to match the data to theoretical type curves to determine the hydraulic parameters of the tested media. Slug test data for unconfined aquifers was analyzed using the Bouwer and Rice (1976) method. Both rising head and falling head data were interpreted for each well. For wells with top of screen and/or sand pack partially above the water table, only rising head data were considered, unless the rising head data were not usable. In these cases, the falling head data were used.

For wells with screen and sand pack fully submerged into the water, the rising head and falling head data were averaged and the average was used for further statistical analysis of hydraulic parameters of the aquifer beneath the site. This was the procedure for monitoring wells at the Annex because none of the well logs indicated confining condition. Interpreted graphics files were used and were saved as input files after a good match was obtained between the observed data and average regression line. The graphics files were then used to plot the slug test, two-dimensional graphics (Appendices G-A and G-B).

The hydraulic conductivity and transmissivity values derived from the curve matching were then reviewed for consistency with the hydraulic conductivity of the type of formation encountered at the site (e.g., glacial till, silty sand, fine, or medium grain sands) as derived from previous investigative records. Wells constructed in formations with low hydraulic conductivity (e.g., in silty or clayey formations) or in very highly permeable formations (e.g., coarse grained sand) indicated very slow or very fast stabilization time, respectively. The resulting slug test data from these extreme types of lithological units were, often, difficult to interpret (e.g., bad data; Table G-2). In general, monitoring wells constructed in formation with hydraulic conductivity in the range of 1 to 10^{-6} feet per minute are most suitable for slug testing.

G.5 SLUG TEST RESULTS

The results of the slug tests performed on newly installed monitoring wells during the 1993 field investigation at the Annex are summarized on Table G-2.

The calculated hydraulic conductivity values from the slug test results range from 2.25×10^{-4} feet per minute, which is the minimum value at monitoring well E3-PO3-MO2, to 3.3×10^{-2} feet per minute, which is the maximum value at monitoring well E3-AO2-MO1.

The calculated average hydraulic conductivity from all slug testing completed in September 1993 at the Annex is 0.00678 feet per minute, with a standard deviation of 0.00831 feet per minute. The tested wells at Annex sites were grouped into four geographical areas by sites as noted below. Calculated average hydraulic conductivity and transmissivity values for individual area tested during the 1993 field investigation at the Sudbury site are as follows:

Site Name	Site No.	Average Hydraulic Conductivity (in feet per minute)	Average Transmissivity (in square feet per minute)
Northern Area of the Annex	A02 P11 P13 P23 P26 P57	0.00934	0.08434
Southern Area of the Annex	A10 P36 P37	0.00583	0.03031
Eastern Area of the Annex	P02 P03	0.00049	0.0078
Western Area of the Annex	A05 P22 P31 P58	0.00622	0.20979

Table G-2

SLUG TEST DATA INTERPRETATION

Well No.	Type of Test	Hydraulic Conductivity (Feet Per Minute)	Transmissivity (Feet Per Minute)	Remarks
Northern Area of the Site:				
E3-A02-MO1	R	0.03266	0.2185	Maximum Hy(1)
E3-P11-MO1	R	0.004169	0.03656	
E3-P13-MO1	R	0.002455	0.01461	
E3-P13-MO2	R+F	0.0102(3)	0.14415(3)	
E3-P13-MO3	R	0.002889	0.03175	
E3-P13-MO4	R	0.005143	0.05878	
E3-P23-MO1	R	0.02542	0.1713	
E3-P26-MO1	R	0.00916	0.1206	
E3-P26-MO2	R	0.009423	0.1179	
E3-P26-MO3	R	0.000864	0.01013	
E3-P57-MO1	R	0.000405	0.003432	
AVERAGE		0.00934	0.08434	
Southern Area of the Site:				
E3-A10-MO1	R	0.00462	0.02772	
E3-P36-MO1	R	0.00347	0.00865	
E3-P36-MO2	R	0.0005793	0.003012	
E3-P36-MO3	R	0.00667	0.03001	
E3-P37-MO1	R	0.008096	0.05821	
E3-P37-MO2	R	0.000793	0.00359	
E3-P37-MO3	R	0.01656	0.0810	
AVERAGE		0.00583	0.03031	
Eastern Area of the Site:				
E3-PO2-MO1	R	0.0003487	0.001981	
E3-PO3-MO1	R+F	0.00091(3)	0.02026	
E3-PO3-MO2	R	0.0002246	0.001145	Minimum Hy(1) & T(2)
AVERAGE		0.00049	0.00780	
Western Area of the Site:				
E3-AO5-MO1	R+F	0.00048(3)	0.01623(3)	
E3-AO6-MO1	Not sufficient water			
E3-P22-MO1	R	0.00453	0.05624	
E3-P31-MO1	R	0.001195	0.01279	
E3-P58-MO1	R	0.02013	0.8376	Maximum T(2)
E3-P58-MO2	R+F	0.00478(3)	0.12608(3)	
Average		0.00622	0.20979	
STATISTICAL ANALYSIS FOR ALL WELLS				
Maximum		0.033 at E3-AO2-MO1	0.8376 at E3-P58-MO1	
Minimum		0.000225 at E3-PO3-MO2	0.00115 at E3-PO3-MO2	
Average		0.00678	0.08509	Average and S Based on 26 data.
Standard Deviation(s)	0.00831	0.16461		Average and S Based on 26 data.

(1) Hy = Hydraulic Conductivity
(2) T = Transmissivity
(3) Average value between rising head and falling head data.
R = Rising Head
F = Falling Head

G.6 CONCLUSIONS

E & E Slug tested a total of 26 out of 27 monitoring wells initially planned fortesting at the Annex. Well information is provided in Table G-1, and the calculated hydraulic parameters of the aquifer beneath the sites are shown in Table G-2. The followings are principal findings and conclusions from these tests.

- In general, the results of the slug tests confirm the findings of boring logs and/or monitoring well installation, at the site (e.g., the lowest hydraulic parameters were identified in well (E3-PO3-MO2) installed in low permeable formation such as silty and clayey sand.

- The water-bearing formation of the northern area of the Annex are characterized by an average hydraulic conductivity of 0.00934 feet per minute and by an average transmissivity of 0.08434 feet^2 per minute. The aquifer in this area may be composed of medium to slightly coarse grained sand with locally silty and fine grained sand (e.g., near E3-P26-MO3 and E3-P57-MO1).

- The aquifer beneath the southern area of the site is characterized by an average hydraulic conductivity of 0.00583 feet per minute and by an average transmissivity of 0.03031 feet^2 per minute, which are indicative of similar formations as the area described above (northern area) with slightly finer-grained sand.

- The water bearing formations in the eastern area of the site are characterized by the lowest hydraulic parameters. This indicates that the water bearing formation in this area is mainly silty and clayey sand. The average hydraulic conductivity of the aquifer beneath this area was 0.00049 feet per minute, with an average transmissivity of 0.0078 feet^2 per minute.

- The water bearing formation in the western area of the site is characterized by an average hydraulic conductivity of 0.00622 feet per minute, and by an average transmissivity of 0.20979 feet^2 per minute. The maximum transmissivity value was identified in this area at well E3-P58-MO1.

APPENDIX G-A
(SLUG TEST)

FALLING HEAD DATA AND INTERPRETED GRAPHS
FORT DEVENS, MASSACHUSETTS SITE

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A02-M01

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:49	Date	09/22 /93
Logger Test	5	INPUT 1 Level (F)	

Step 0 09/22 14:06:18

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	1.059	0.3250	0.094
0.0083	1.163	0.3333	0.091
0.0166	1.223	0.3500	0.091
0.0250	1.103	0.3666	0.088
0.0333	0.722	0.3833	0.088
0.0416	-0.365	0.4000	0.085
0.0500	0.378	0.4166	0.082
0.0583	0.211	0.4333	0.082
0.0666	0.192	0.4500	0.078
0.0750	0.179	0.4666	0.078
0.0833	0.173	0.4833	0.075
0.0916	0.167	0.5000	0.075
0.1000	0.160	0.5166	0.072
0.1083	0.154	0.5333	0.072
0.1166	0.151	0.5500	0.069
0.1250	0.145	0.5666	0.069
0.1333	0.141	0.5833	0.069
0.1416	0.138	0.6000	0.066
0.1500	0.135	0.6166	0.066
0.1583	0.132	0.6333	0.066
0.1666	0.129	0.6500	0.066
0.1750	0.126	0.6666	0.063
0.1833	0.126	0.6833	0.063
0.1916	0.123	0.7000	0.063
0.2000	0.119	0.7166	0.063
0.2083	0.116	0.7333	0.059
0.2166	0.116	0.7500	0.059
0.2250	0.113	0.7666	0.056
0.2333	0.110	0.7833	0.056
0.2416	0.110	0.8000	0.056
0.2500	0.107	0.8166	0.056
0.2583	0.107	0.8333	0.053
0.2666	0.104	0.8500	0.053
0.2750	0.104	0.8666	0.053
0.2833	0.100	0.8833	0.053
0.2916	0.100	0.9000	0.053
0.3000	0.097	0.9166	0.050
0.3083	0.097	0.9333	0.050
0.3166	0.094	0.9500	0.050

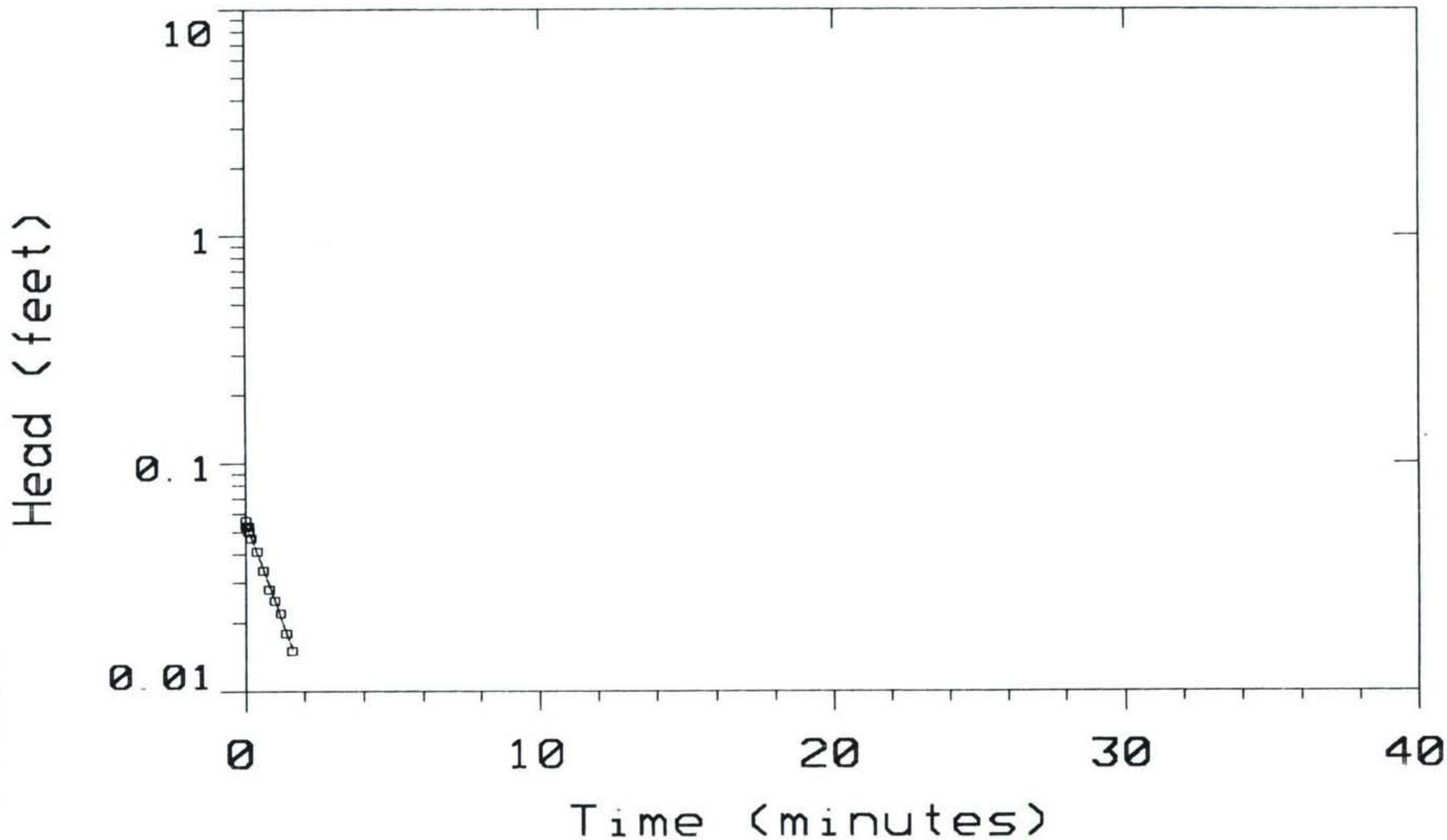
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A02-M01

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:49	Date	09/22 /93
Logger Test	5	INPUT 1 Level (F)	

Step 0 09/22 14:06:18

Elapsed Time	INPUT 1
0.9666	0.047
0.9833	0.047
1.0000	0.047
1.2000	0.041
1.4000	0.034
1.6000	0.028
1.8000	0.025
2.0000	0.022
2.2000	0.018
2.4000	0.015
2.6000	0.012
2.8000	0.012
3.0000	0.012
3.2000	0.009
3.4000	0.009
3.6000	0.009
3.8000	0.006
4.0000	0.006
4.2000	0.006
4.4000	0.006
4.6000	0.003
4.8000	0.003
5.0000	0.003
5.2000	0.003
5.4000	0.003
5.6000	0.003
5.8000	0.003
6.0000	0.003
6.2000	0.003
6.4000	0.003
6.6000	0.003
6.8000	0.000
7.0000	0.000
7.2000	0.000
7.4000	0.000
7.6000	0.000
7.8000	0.000
8.0000	0.000
8.2000	0.000

Elapsed Time	INPUT 1
8.4000	0.000
8.6000	0.000
8.8000	0.000
9.0000	0.000
9.2000	0.000
9.4000	0.000



MODEL TYPE: BOUWER and RICE	for **USAEC**	Well Slug Test Data
CONDUCTIVITY: .003222 ft/min	by Ecology & Environment	Well: E3-A2-M01
TRANSMISSIVITY: .02156 sq ft/min	WELL DATA Units: ft	SUDBURY, MA
INITIAL HEAD: .05600 ft	AQUIFER: Endless	SUDBURY
Data Set: A2MIS0	THICKNESS: 6.690	
Date: 9-22-93	SCREEN top 10.00 base 20.00	
	DIAMETER casing .3400 intake .3400	
	DEPTH: Water Table 13.58 TD 20.27	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A05-M01

Reference	0.000
SG	1.000
Linearity	0.004
Time	19:50
Logger Test	1

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/20 /93
INPUT 1 Level (F)	

Step 0 09/20 16:00:31

Elapsed Time	INPUT 1
0.0000	-0.031
0.0083	-0.003
0.0166	0.000
0.0250	0.028
0.0333	0.031
0.0416	0.031
0.0500	2.003
0.0583	2.733
0.0666	3.264
0.0750	4.261
0.0833	4.290
0.0916	4.378
0.1000	4.299
0.1083	4.496
0.1166	4.394
0.1250	4.423
0.1333	4.350
0.1416	4.442
0.1500	4.512
0.1583	4.321
0.1666	3.880
0.1750	3.464
0.1833	3.083
0.1916	3.130
0.2000	2.244
0.2083	2.594
0.2166	2.775
0.2250	2.778
0.2333	2.718
0.2416	2.743
0.2500	2.718
0.2583	2.730
0.2666	2.711
0.2750	2.705
0.2833	2.699
0.2916	2.689
0.3000	2.683
0.3083	2.676
0.3166	2.670

Elapsed Time	INPUT 1
0.3250	2.664
0.3333	2.657
0.3500	2.645
0.3666	2.632
0.3833	2.622
0.4000	2.610
0.4166	2.600
0.4333	2.591
0.4500	2.584
0.4666	2.575
0.4833	2.568
0.5000	2.562
0.5166	2.552
0.5333	2.546
0.5500	2.540
0.5666	2.533
0.5833	2.527
0.6000	2.521
0.6166	2.514
0.6333	2.508
0.6500	2.502
0.6666	2.498
0.6833	2.492
0.7000	2.486
0.7166	2.483
0.7333	2.476
0.7500	2.470
0.7666	2.467
0.7833	2.464
0.8000	2.457
0.8166	2.451
0.8333	2.445
0.8500	2.441
0.8666	2.438
0.8833	2.432
0.9000	2.425
0.9166	2.422
0.9333	2.416
0.9500	2.410

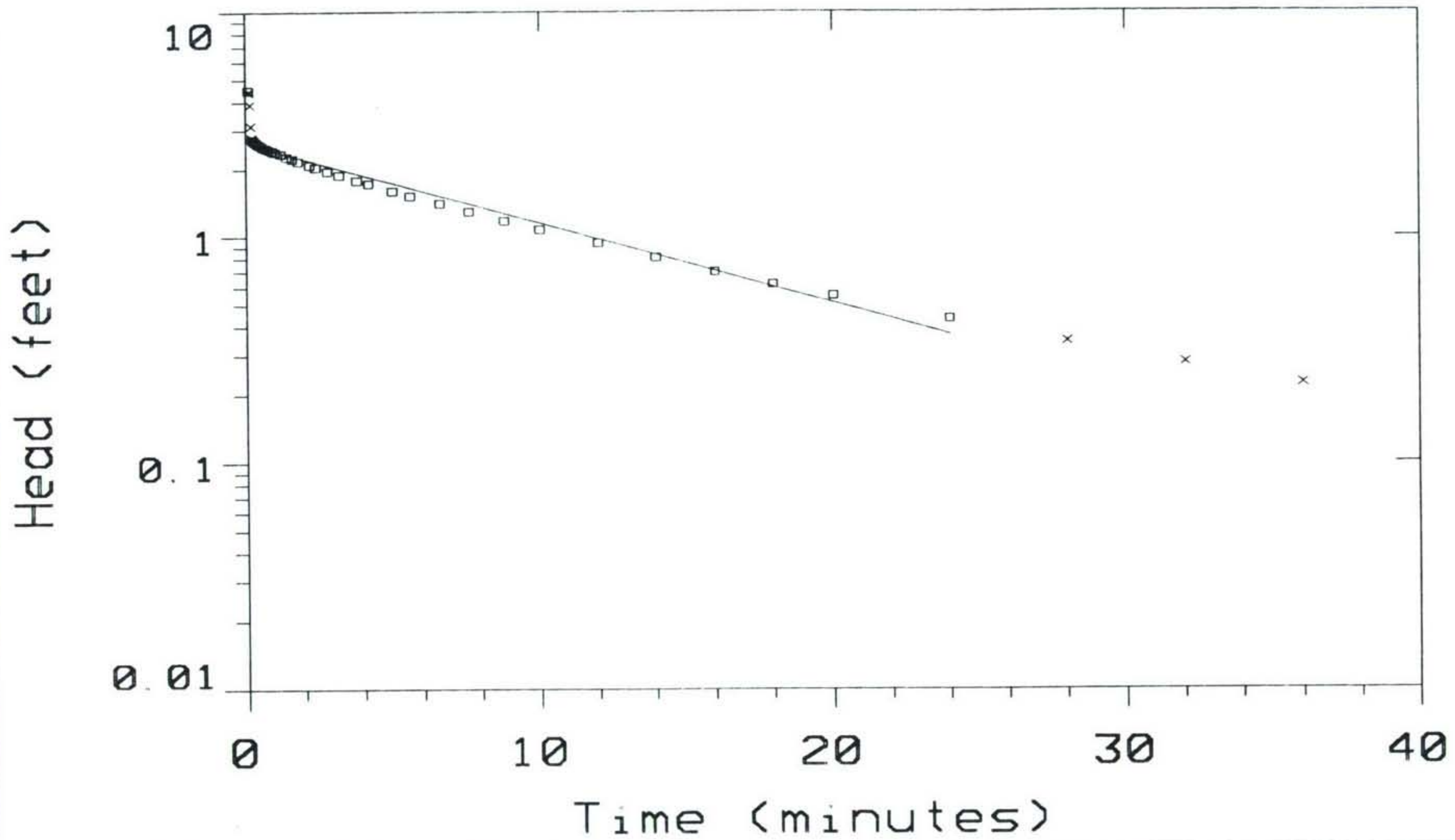
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A05-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:50	Date	09/20 /93
Logger Test	1	INPUT 1 Level (F)	

Step 0 09/20 16:00:31

Elapsed Time	INPUT 1
0.9666	2.406
0.9833	2.400
1.0000	2.397
1.2000	2.346
1.4000	2.279
1.6000	2.232
1.8000	2.184
2.0000	2.133
2.2000	2.098
2.4000	2.041
2.6000	2.009
2.8000	1.962
3.0000	1.936
3.2000	1.895
3.4000	1.857
3.6000	1.822
3.8000	1.787
4.0000	1.762
4.2000	1.727
4.4000	1.698
4.6000	1.663
4.8000	1.638
5.0000	1.609
5.2000	1.584
5.4000	1.555
5.6000	1.530
5.8000	1.505
6.0000	1.479
6.2000	1.457
6.4000	1.435
6.6000	1.412
6.8000	1.384
7.0000	1.365
7.2000	1.346
7.4000	1.317
7.6000	1.305
7.8000	1.282
8.0000	1.254
8.2000	1.235

Elapsed Time	INPUT 1
8.4000	1.219
8.6000	1.193
8.8000	1.181
9.0000	1.165
9.2000	1.143
9.4000	1.136
9.6000	1.117
9.8000	1.095
10.0000	1.085
12.0000	0.939
14.0000	0.812
16.0000	0.704
18.0000	0.619
20.0000	0.552
22.0000	0.495
24.0000	0.435
26.0000	0.387
28.0000	0.346
30.0000	0.301
32.0000	0.279
34.0000	0.250
36.0000	0.225



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 0005328 ft/min	by Ecology & Environment	Well: E3-A5-M01
TRANSMISSIVITY 01553 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 4 496 ft	AQUIFER Endless	SUDBURY
Data Set E3A5S0	THICKNESS 29 15	
Date 9-20-93	SCREEN top 31 00 base 41 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 12 38 TD 41 53	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A10-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:54	Date	09/22 /93
Logger Test	4	INPUT 1 Level (F)	

Step 0 09/22 11:36:05

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.000	0.3250	0.117
0.0083	-0.003	0.3333	0.114
0.0166	-0.009	0.3500	0.111
0.0250	0.000	0.3666	0.104
0.0333	0.019	0.3833	0.101
0.0416	0.047	0.4000	0.098
0.0500	0.593	0.4166	0.092
0.0583	0.695	0.4333	0.088
0.0666	0.618	0.4500	0.085
0.0750	0.739	0.4666	0.082
0.0833	0.447	0.4833	0.079
0.0916	0.330	0.5000	0.079
0.1000	0.418	0.5166	0.076
0.1083	0.764	0.5333	0.073
0.1166	0.050	0.5500	0.073
0.1250	0.190	0.5666	0.069
0.1333	0.539	0.5833	0.069
0.1416	0.272	0.6000	0.066
0.1500	0.161	0.6166	0.066
0.1583	0.212	0.6333	0.063
0.1666	0.199	0.6500	0.063
0.1750	0.193	0.6666	0.063
0.1833	0.190	0.6833	0.060
0.1916	0.184	0.7000	0.060
0.2000	0.177	0.7166	0.060
0.2083	0.171	0.7333	0.060
0.2166	0.168	0.7500	0.057
0.2250	0.161	0.7666	0.057
0.2333	0.158	0.7833	0.057
0.2416	0.152	0.8000	0.057
0.2500	0.149	0.8166	0.053
0.2583	0.146	0.8333	0.053
0.2666	0.142	0.8500	0.053
0.2750	0.136	0.8666	0.053
0.2833	0.133	0.8833	0.053
0.2916	0.130	0.9000	0.053
0.3000	0.126	0.9166	0.050
0.3083	0.123	0.9333	0.053
0.3166	0.120	0.9500	0.050

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A10-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:54	Date	09/22 /93
Logger Test	4	INPUT 1 Level (F)	

Step 0 09/22 11:36:05

Elapsed Time	INPUT 1
0.9666	0.050
0.9833	0.050
1.0000	0.050
1.2000	0.047
1.4000	0.047
1.6000	0.044
1.8000	0.044
2.0000	0.044
2.2000	0.044
2.4000	0.044
2.6000	0.044
2.8000	0.041
3.0000	0.041
3.2000	0.041
3.4000	0.041
3.6000	0.041
3.8000	0.041
4.0000	0.041
4.2000	0.041
4.4000	0.041
4.6000	0.041
4.8000	0.041
5.0000	0.041
5.2000	0.041
5.4000	0.041
5.6000	0.041
5.8000	0.041
6.0000	0.041
6.2000	0.041
6.4000	0.041
6.6000	0.041
6.8000	0.041
7.0000	0.041
7.2000	0.041
7.4000	0.041
7.6000	0.041
7.8000	0.041
8.0000	0.041
8.2000	0.041

Elapsed Time	INPUT 1
8.4000	0.041
8.6000	0.041
8.8000	0.041
9.0000	0.041
9.2000	0.041
9.4000	0.041
9.6000	0.041
9.8000	0.041
10.0000	0.041
12.0000	0.038
14.0000	0.038
16.0000	0.038
18.0000	0.038
20.0000	0.038
22.0000	0.038
24.0000	0.038
26.0000	0.038
28.0000	0.038
30.0000	0.038
32.0000	0.038
34.0000	0.038
36.0000	0.038
38.0000	0.038
40.0000	0.038
42.0000	0.038
44.0000	0.038
46.0000	0.038
48.0000	0.038
50.0000	0.038
52.0000	0.038
54.0000	0.038
56.0000	0.038
58.0000	0.038
60.0000	0.038
62.0000	0.038
64.0000	0.038
66.0000	0.038
68.0000	0.038
70.0000	0.038

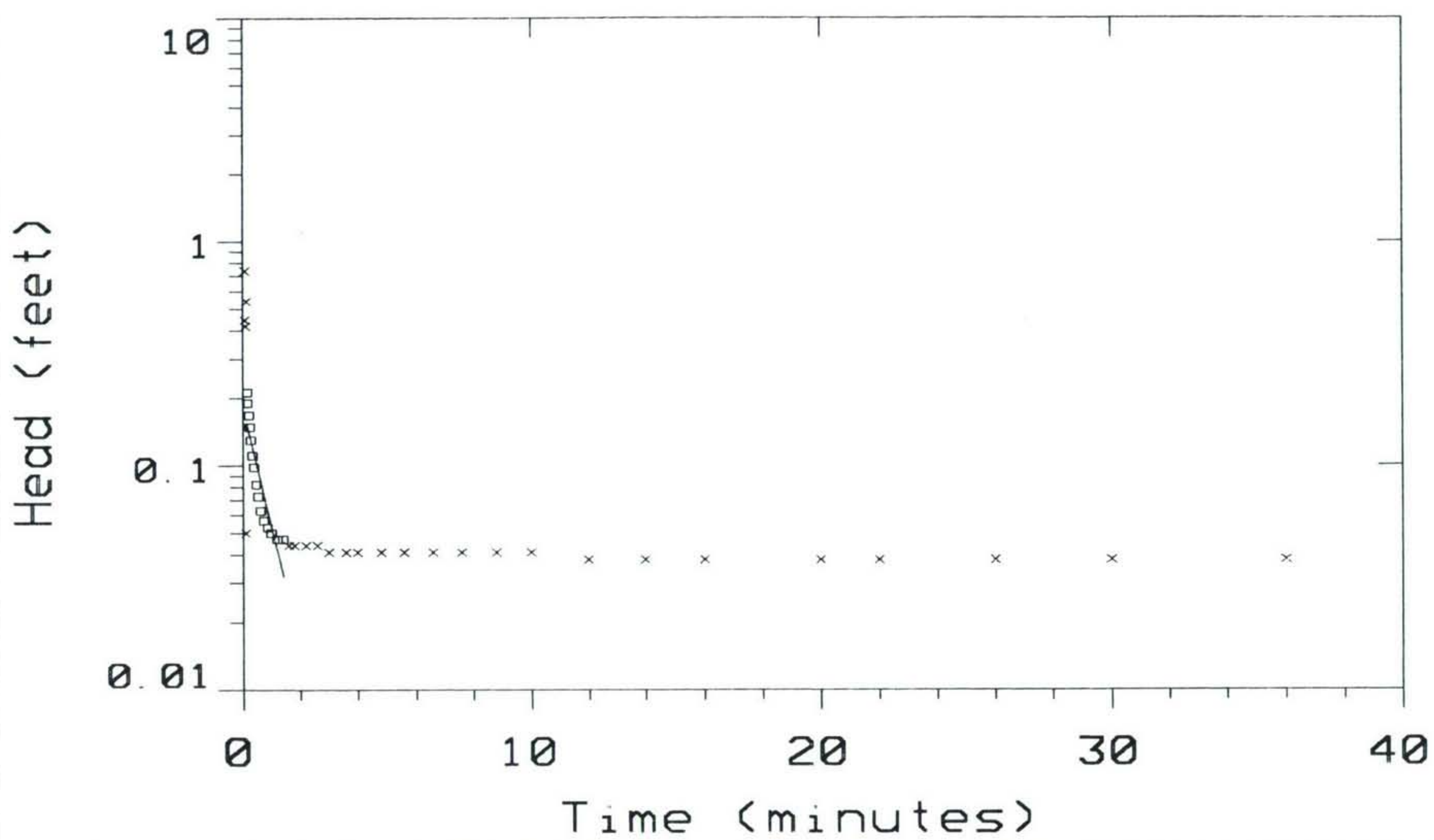
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A10-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:54	Date	09/22 /93
Logger Test	4	INPUT 1 Level (F)	

Step 0 09/22 11:36:05

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
72.0000	0.038		
74.0000	0.038		
76.0000	0.038		
78.0000	0.038		

G-34



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY .008236 ft/min	
TRANSMISSIVITY .04941 sq. ft/min	
INITIAL HEAD .7390 ft	
Data Set A10MIS0	Date 9-22-93

for **USAEC**
by Ecology & Environment
WELL DATA Units ft
AQUIFER Endless
THICKNESS 6.000
SCREEN top 10.00 base 20.00
DIAMETER casing .3400 intake .3400
DEPTH Water Table 14.82 TD 20.82

Well Slug Test Data
Well: E3-A10-M01
SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P02-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:47	Date	09/20 /93
Logger Test	2	INPUT 1 Level (F)	

Step 0 09/20 17:36:18

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.704	0.3250	0.485
0.0083	0.831	0.3333	0.485
0.0166	0.710	0.3500	0.482
0.0250	0.917	0.3666	0.479
0.0333	1.069	0.3833	0.472
0.0416	1.139	0.4000	0.472
0.0500	1.104	0.4166	0.472
0.0583	0.869	0.4333	0.472
0.0666	0.552	0.4500	0.469
0.0750	0.368	0.4666	0.469
0.0833	0.637	0.4833	0.466
0.0916	0.726	0.5000	0.466
0.1000	0.523	0.5166	0.463
0.1083	0.469	0.5333	0.463
0.1166	0.511	0.5500	0.460
0.1250	0.498	0.5666	0.460
0.1333	0.498	0.5833	0.457
0.1416	0.507	0.6000	0.457
0.1500	0.498	0.6166	0.453
0.1583	0.498	0.6333	0.453
0.1666	0.495	0.6500	0.450
0.1750	0.498	0.6666	0.450
0.1833	0.495	0.6833	0.450
0.1916	0.485	0.7000	0.447
0.2000	0.495	0.7166	0.447
0.2083	1.158	0.7333	0.447
0.2166	0.390	0.7500	0.444
0.2250	-0.038	0.7666	0.444
0.2333	0.555	0.7833	0.444
0.2416	0.622	0.8000	0.441
0.2500	0.469	0.8166	0.441
0.2583	0.457	0.8333	0.441
0.2666	0.501	0.8500	0.438
0.2750	0.495	0.8666	0.438
0.2833	0.491	0.8833	0.438
0.2916	0.488	0.9000	0.438
0.3000	0.488	0.9166	0.434
0.3083	0.488	0.9333	0.434
0.3166	0.485	0.9500	0.431

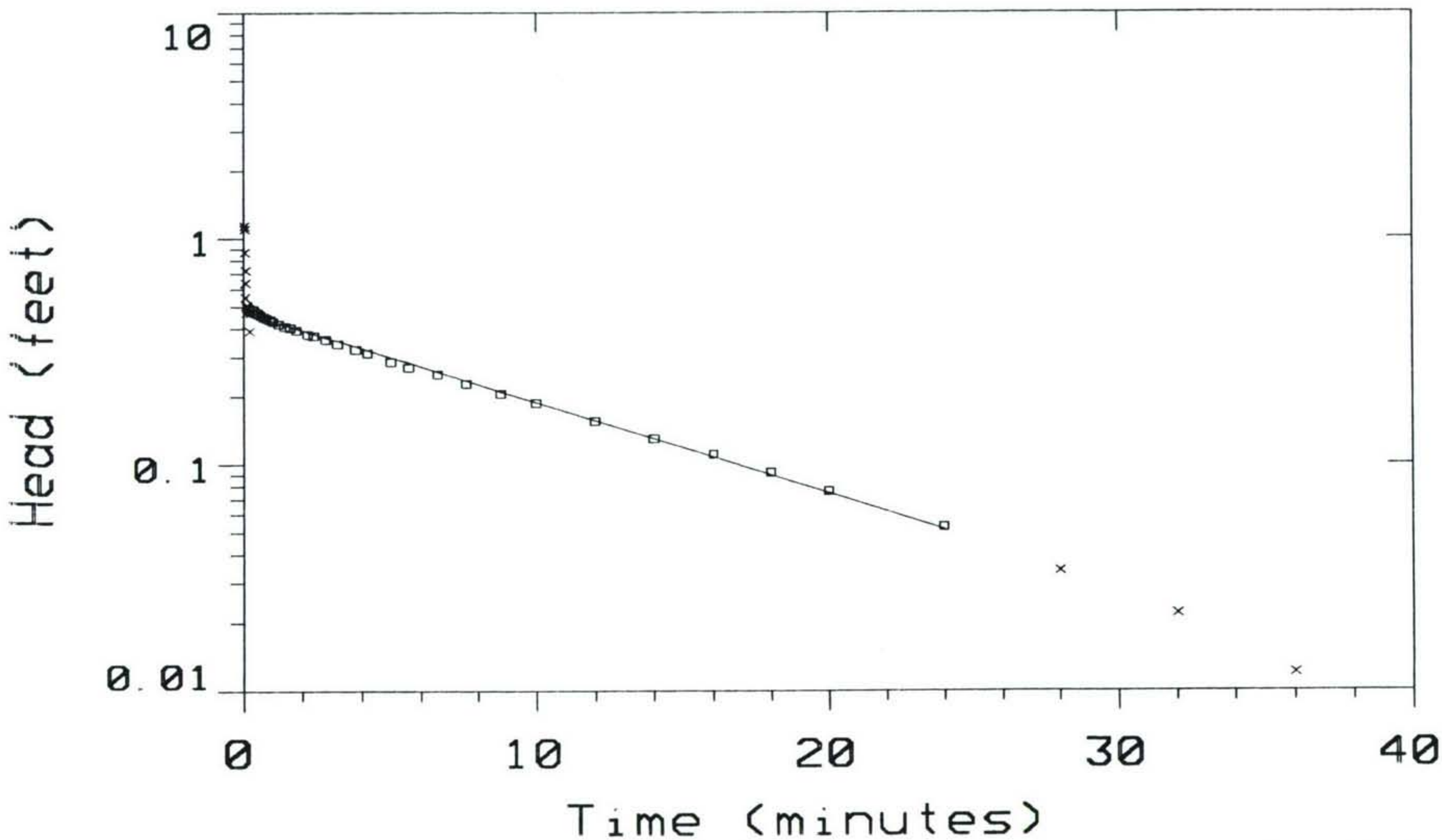
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P02-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:47	Date	09/20 /93
Logger Test	2	INPUT 1 Level (F)	

Step 0 09/20 17:36:18

Elapsed Time	INPUT 1
0.9666	0.431
0.9833	0.431
1.0000	0.431
1.2000	0.418
1.4000	0.409
1.6000	0.403
1.8000	0.393
2.0000	0.387
2.2000	0.377
2.4000	0.371
2.6000	0.365
2.8000	0.358
3.0000	0.352
3.2000	0.342
3.4000	0.336
3.6000	0.330
3.8000	0.323
4.0000	0.317
4.2000	0.311
4.4000	0.304
4.6000	0.298
4.8000	0.295
5.0000	0.285
5.2000	0.282
5.4000	0.276
5.6000	0.269
5.8000	0.266
6.0000	0.263
6.2000	0.257
6.4000	0.253
6.6000	0.250
6.8000	0.244
7.0000	0.241
7.2000	0.238
7.4000	0.234
7.6000	0.228
7.8000	0.225
8.0000	0.222
8.2000	0.219

Elapsed Time	INPUT 1
8.4000	0.212
8.6000	0.212
8.8000	0.206
9.0000	0.203
9.2000	0.199
9.4000	0.196
9.6000	0.193
9.8000	0.190
10.0000	0.187
12.0000	0.155
14.0000	0.130
16.0000	0.111
18.0000	0.092
20.0000	0.076
22.0000	0.063
24.0000	0.053
26.0000	0.041
28.0000	0.034
30.0000	0.028
32.0000	0.022
34.0000	0.015
36.0000	0.012



MODEL TYPE: BOUWER and RICE

CONDUCTIVITY: .0004584 ft/min

TRANSMISSIVITY: .002603 sq. ft/min

INITIAL HEAD: 1.139 ft

Data Set: E3P2S0 | Date: 9-20-93

for: **USAEC**

by: Ecology & Environment

WELL DATA: Units: ft

AQUIFER: Endless

THICKNESS: 5.680

SCREEN: top 10.00 base 20.00

DIAMETER: casing .3400 intake .3400

DEPTH: Water Table: 15.35 TD: 21.03

Well Slug Test Data

Well: E3-P02-M01

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M01

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	20:06		Date	09/21 /93
Logger Test	5		INPUT 1 Level (F)	

Step 0 09/21 15:47:59

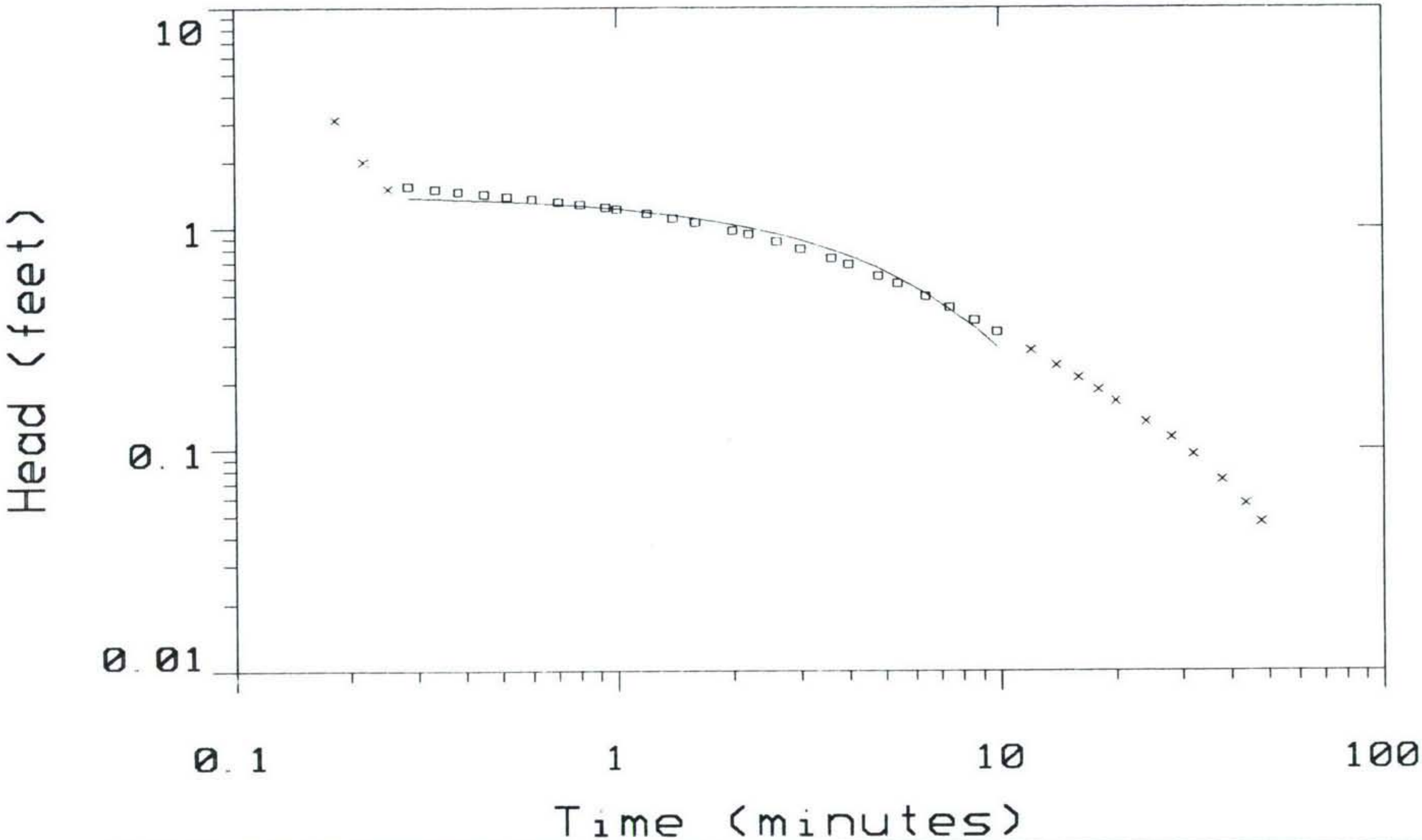
Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-0.006	0.3250	1.511
0.0083	-0.006	0.3333	1.505
0.0166	-0.012	0.3500	1.492
0.0250	-0.003	0.3666	1.482
0.0333	-0.006	0.3833	1.470
0.0416	-0.012	0.4000	1.460
0.0500	-0.009	0.4166	1.451
0.0583	-0.006	0.4333	1.441
0.0666	-0.015	0.4500	1.432
0.0750	-0.003	0.4666	1.422
0.0833	-0.009	0.4833	1.416
0.0916	-0.006	0.5000	1.406
0.1000	0.577	0.5166	1.397
0.1083	1.448	0.5333	1.390
0.1166	1.127	0.5500	1.384
0.1250	2.657	0.5666	1.378
0.1333	2.696	0.5833	1.368
0.1416	2.578	0.6000	1.362
0.1500	1.438	0.6166	1.355
0.1583	2.845	0.6333	1.349
0.1666	3.226	0.6500	1.340
0.1750	2.867	0.6666	1.333
0.1833	3.121	0.6833	1.327
0.1916	1.568	0.7000	1.320
0.2000	1.803	0.7166	1.317
0.2083	1.222	0.7333	1.311
0.2166	2.010	0.7500	1.301
0.2250	1.270	0.7666	1.298
0.2333	1.584	0.7833	1.292
0.2416	1.705	0.8000	1.286
0.2500	1.517	0.8166	1.279
0.2583	1.597	0.8333	1.276
0.2666	1.575	0.8500	1.267
0.2750	1.546	0.8666	1.263
0.2833	1.555	0.8833	1.257
0.2916	1.540	0.9000	1.251
0.3000	1.530	0.9166	1.247
0.3083	1.527	0.9333	1.241
0.3166	1.517	0.9500	1.235

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:06	Date	09/21 /93
Logger Test	5	INPUT 1 Level (F)	

Step 0 09/21 15:47:59

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.9666	1.232	8.4000	0.396
0.9833	1.225	8.6000	0.387
1.0000	1.222	8.8000	0.381
1.2000	1.165	9.0000	0.371
1.4000	1.111	9.2000	0.365
1.6000	1.063	9.4000	0.358
1.8000	1.019	9.6000	0.352
2.0000	0.978	9.8000	0.342
2.2000	0.939	10.0000	0.339
2.4000	0.904	12.0000	0.282
2.6000	0.870	14.0000	0.241
2.8000	0.841	16.0000	0.212
3.0000	0.809	18.0000	0.187
3.2000	0.784	20.0000	0.165
3.4000	0.758	22.0000	0.149
3.6000	0.733	24.0000	0.133
3.8000	0.711	26.0000	0.123
4.0000	0.689	28.0000	0.114
4.2000	0.670	30.0000	0.101
4.4000	0.647	32.0000	0.095
4.6000	0.628	34.0000	0.085
4.8000	0.612	36.0000	0.079
5.0000	0.596	38.0000	0.073
5.2000	0.581	40.0000	0.066
5.4000	0.565	42.0000	0.063
5.6000	0.549	44.0000	0.057
5.8000	0.536	46.0000	0.053
6.0000	0.523	48.0000	0.047
6.2000	0.511	50.0000	-0.276
6.4000	0.495		
6.6000	0.485		
6.8000	0.473		
7.0000	0.463		
7.2000	0.454		
7.4000	0.441		
7.6000	0.431		
7.8000	0.422		
8.0000	0.412		
8.2000	0.403		



MODEL TYPE: BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 001133 ft/min	by Ecology & Environment	Well: E3-P03-M01
TRANSMISSIVITY 02533 sq ft/min	WELL DATA Units: ft	SUDBURY, MA
INITIAL HEAD 3 110 ft	AQUIFER Endless	SUDBURY
Data Set P3M1S0 Date 9-21-93	THICKNESS 22 36	
	SCREEN top 50 00 base 60 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 39 28 TD 61 64	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M02

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	07:38		Date	09/23 /93
Logger Test	1		INPUT 1 Level (F)	

Step 0 09/22 07:59:07

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.006	0.3250	0.374
0.0083	0.009	0.3333	0.374
0.0166	0.009	0.3500	0.371
0.0250	2.107	0.3666	0.371
0.0333	1.980	0.3833	0.371
0.0416	1.320	0.4000	0.371
0.0500	0.818	0.4166	0.368
0.0583	0.295	0.4333	0.368
0.0666	0.549	0.4500	0.368
0.0750	0.193	0.4666	0.364
0.0833	0.396	0.4833	0.364
0.0916	0.393	0.5000	0.364
0.1000	0.387	0.5166	0.364
0.1083	0.387	0.5333	0.364
0.1166	0.387	0.5500	0.361
0.1250	0.384	0.5666	0.361
0.1333	0.384	0.5833	0.361
0.1416	0.380	0.6000	0.361
0.1500	0.384	0.6166	0.358
0.1583	0.380	0.6333	0.358
0.1666	0.380	0.6500	0.358
0.1750	0.384	0.6666	0.358
0.1833	0.380	0.6833	0.358
0.1916	0.380	0.7000	0.355
0.2000	0.380	0.7166	0.355
0.2083	0.380	0.7333	0.355
0.2166	0.380	0.7500	0.355
0.2250	0.380	0.7666	0.352
0.2333	0.377	0.7833	0.352
0.2416	0.377	0.8000	0.352
0.2500	0.377	0.8166	0.352
0.2583	0.377	0.8333	0.349
0.2666	0.377	0.8500	0.349
0.2750	0.374	0.8666	0.349
0.2833	0.374	0.8833	0.349
0.2916	0.374	0.9000	0.345
0.3000	0.374	0.9166	0.345
0.3083	0.374	0.9333	0.345
0.3166	0.374	0.9500	0.345

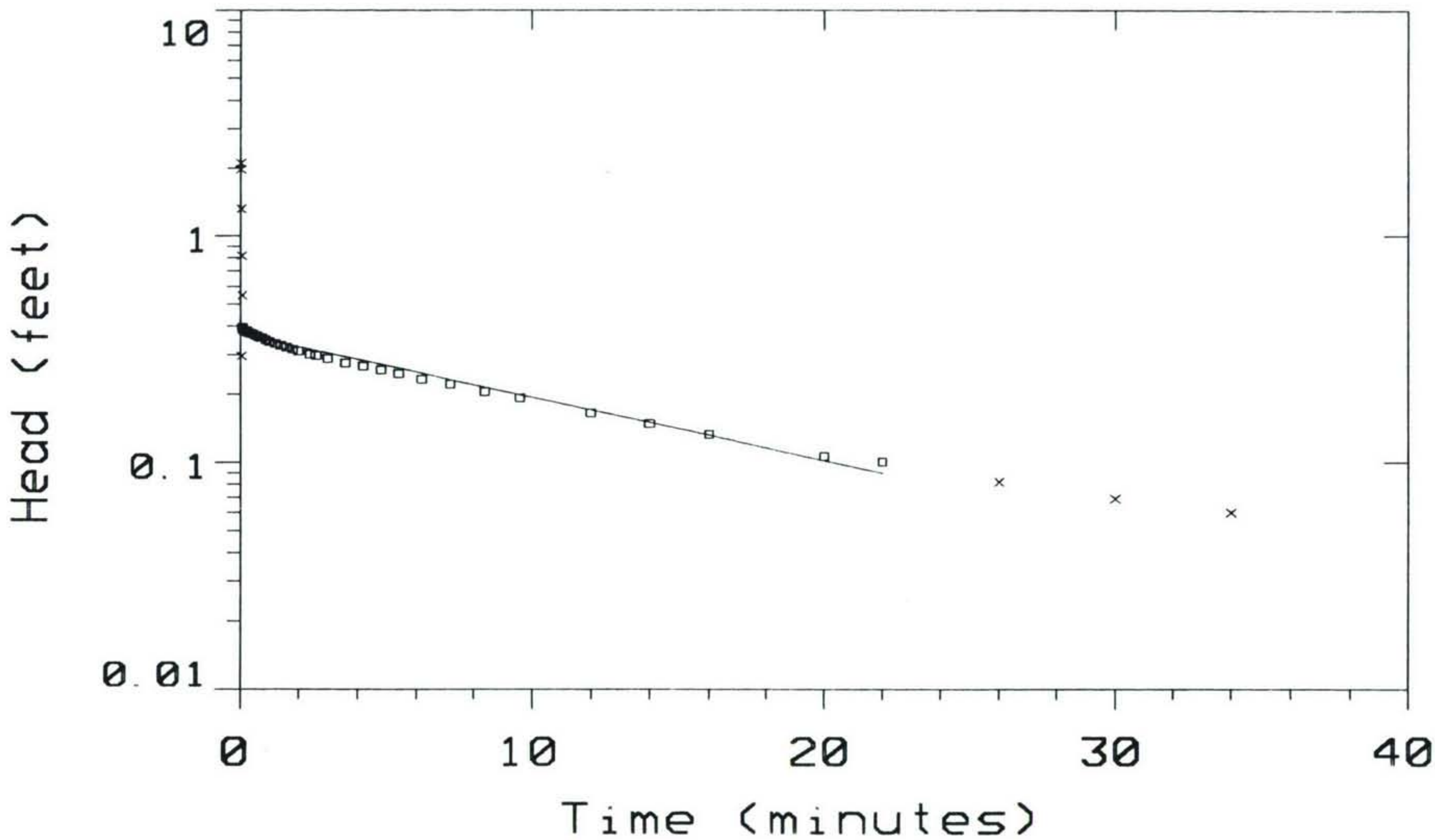
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M02

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	07:38		Date	09/23 /93
Logger Test	1		INPUT 1 Level (F)	

Step 0 09/22 07:59:07

Elapsed Time	INPUT 1
0.9666	0.345
0.9833	0.342
1.0000	0.342
1.2000	0.336
1.4000	0.330
1.6000	0.323
1.8000	0.317
2.0000	0.311
2.2000	0.307
2.4000	0.301
2.6000	0.298
2.8000	0.295
3.0000	0.288
3.2000	0.285
3.4000	0.282
3.6000	0.276
3.8000	0.272
4.0000	0.269
4.2000	0.266
4.4000	0.263
4.6000	0.260
4.8000	0.257
5.0000	0.253
5.2000	0.250
5.4000	0.247
5.6000	0.244
5.8000	0.241
6.0000	0.238
6.2000	0.234
6.4000	0.231
6.6000	0.228
6.8000	0.225
7.0000	0.222
7.2000	0.222
7.4000	0.218
7.6000	0.215
7.8000	0.212
8.0000	0.209
8.2000	0.209

Elapsed Time	INPUT 1
8.4000	0.206
8.6000	0.203
8.8000	0.199
9.0000	0.196
9.2000	0.196
9.4000	0.193
9.6000	0.193
9.8000	0.190
10.0000	0.187
12.0000	0.165
14.0000	0.149
16.0000	0.133
18.0000	0.123
20.0000	0.107
22.0000	0.101
24.0000	0.092
26.0000	0.082
28.0000	0.076
30.0000	0.069
32.0000	0.066
34.0000	0.060



MODEL TYPE: BOUWER and RICE	for: USAEC	Well Slug Test Data
CONDUCTIVITY: .001355 ft/min	by: Ecology & Environment	Well: E3-P03-M02
TRANSMISSIVITY: .006911 sq. ft/min	WELL DATA: Units: ft	SUDBURY, MA
INITIAL HEAD: 2.107 ft	AQUIFER: Endless	SUDBURY
Data Set: P3M2S0	THICKNESS: 5.100	
Date: 9-22-93	SCREEN: top: 5.000 base: 15.00	
	DIAMETER: casing: .6680 intake: .6680	
	DEPTH: Water Table: 11.83 TD: 16.93	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P11-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:06	Date	09/23 /93
Logger Test	1	INPUT 1 Level (F)	

Step 0 09/23 08:22:31

Elapsed Time	INPUT 1
0.0000	0.025
0.0083	0.028
0.0166	0.044
0.0250	0.028
0.0333	1.815
0.0416	0.968
0.0500	4.053
0.0583	4.892
0.0666	5.158
0.0750	5.314
0.0833	5.403
0.0916	5.419
0.1000	5.352
0.1083	4.180
0.1166	2.326
0.1250	4.009
0.1333	3.212
0.1416	3.482
0.1500	3.444
0.1583	3.412
0.1666	3.428
0.1750	3.422
0.1833	3.415
0.1916	3.412
0.2000	3.409
0.2083	3.406
0.2166	3.403
0.2250	3.399
0.2333	3.393
0.2416	3.393
0.2500	3.387
0.2583	3.384
0.2666	3.380
0.2750	3.377
0.2833	3.374
0.2916	3.368
0.3000	3.365
0.3083	3.361
0.3166	3.358

Elapsed Time	INPUT 1
0.3250	3.355
0.3333	3.352
0.3500	3.345
0.3666	3.339
0.3833	3.330
0.4000	3.323
0.4166	3.317
0.4333	3.311
0.4500	3.304
0.4666	3.298
0.4833	3.292
0.5000	3.285
0.5166	3.279
0.5333	3.272
0.5500	3.266
0.5666	3.263
0.5833	3.257
0.6000	3.250
0.6166	3.244
0.6333	3.238
0.6500	3.231
0.6666	3.225
0.6833	3.222
0.7000	3.215
0.7166	3.209
0.7333	3.206
0.7500	3.199
0.7666	3.193
0.7833	3.187
0.8000	3.184
0.8166	3.177
0.8333	3.171
0.8500	3.168
0.8666	3.161
0.8833	3.158
0.9000	3.152
0.9166	3.145
0.9333	3.142
0.9500	3.136

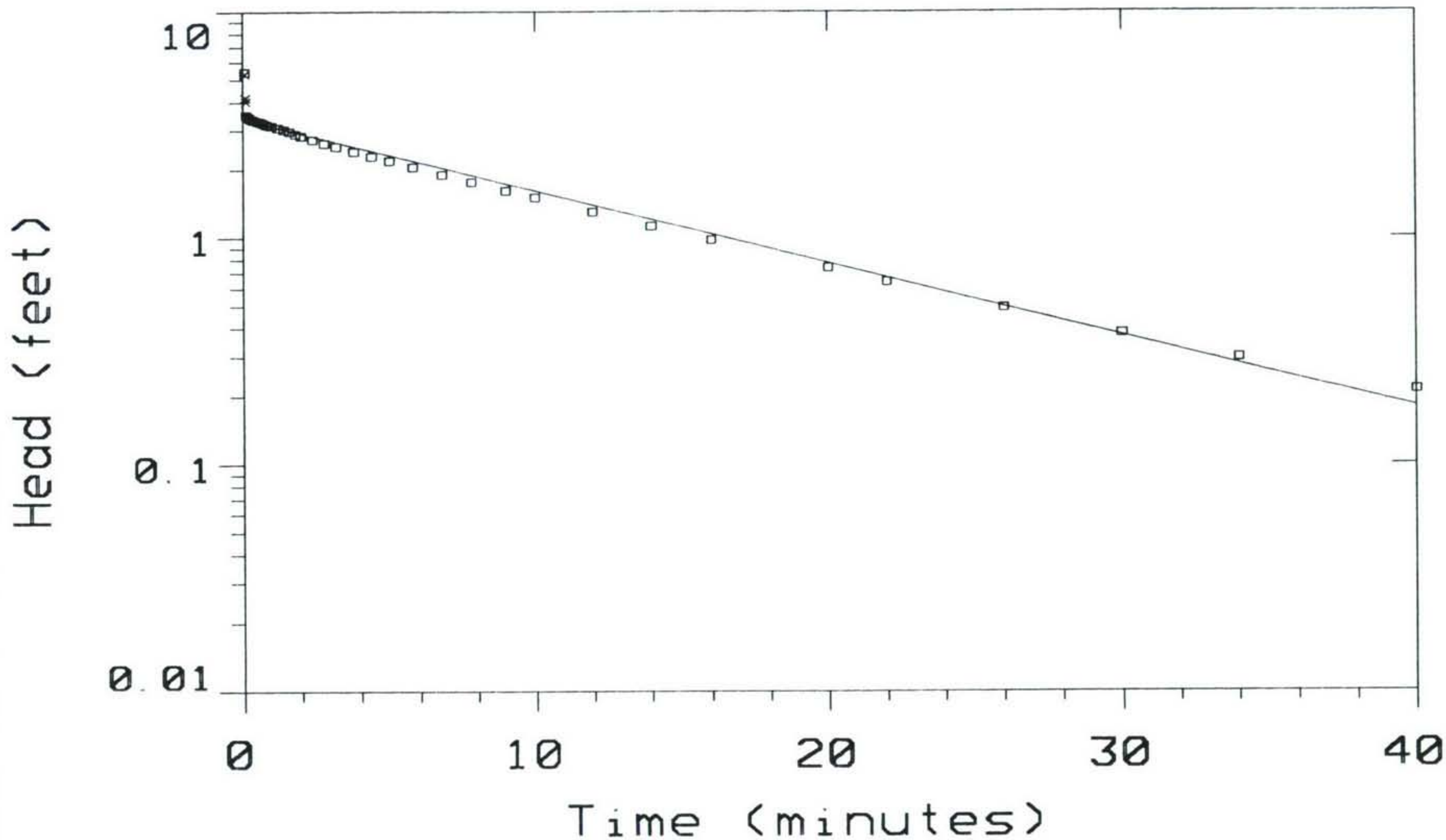
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P11-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:06	Date	09/23 /93
Logger Test	1	INPUT 1 Level (F)	

Step 0 09/23 08:22:31

Elapsed Time	INPUT 1
0.9666	3.130
0.9833	3.126
1.0000	3.120
1.2000	3.063
1.4000	3.009
1.6000	2.949
1.8000	2.888
2.0000	2.831
2.2000	2.777
2.4000	2.723
2.6000	2.676
2.8000	2.628
3.0000	2.580
3.2000	2.536
3.4000	2.495
3.6000	2.450
3.8000	2.412
4.0000	2.371
4.2000	2.333
4.4000	2.295
4.6000	2.260
4.8000	2.222
5.0000	2.187
5.2000	2.155
5.4000	2.120
5.6000	2.088
5.8000	2.057
6.0000	2.025
6.2000	1.993
6.4000	1.961
6.6000	1.933
6.8000	1.904
7.0000	1.876
7.2000	1.847
7.4000	1.818
7.6000	1.793
7.8000	1.768
8.0000	1.739
8.2000	1.714

Elapsed Time	INPUT 1
8.4000	1.688
8.6000	1.666
8.8000	1.641
9.0000	1.615
9.2000	1.593
9.4000	1.571
9.6000	1.545
9.8000	1.526
10.0000	1.504
12.0000	1.298
14.0000	1.123
16.0000	0.974
18.0000	0.847
20.0000	0.739
22.0000	0.644
24.0000	0.565
26.0000	0.495
28.0000	0.431
30.0000	0.380
32.0000	0.336
34.0000	0.298
36.0000	0.266
38.0000	0.238
40.0000	0.212
42.0000	0.190
44.0000	0.171
46.0000	0.152
48.0000	0.133
50.0000	0.120
52.0000	0.107
54.0000	0.095



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY .0003599 ft/min	
TRANSMISSIVITY .003156 sq ft/min	
INITIAL HEAD 5 314 ft	
Data Set P11M1S0	Date 9-23-93

for USAEC
by Ecology & Environment
WELL DATA Units ft
AQUIFER Endless
THICKNESS 8 770
SCREEN top 8 000 base 18 00
DIAMETER casing 3400 intake 3400
DEPTH Water Table 9 440 TD 18 21

Well Slug Test Data

Well: E3-P11-M01

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M01

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:41	Date	09/22 /93
Logger Test	7	INPUT 1 Level (F)	

Step 0 09/22 16:13:25

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.003	0.3250	0.365
0.0083	0.003	0.3333	0.362
0.0166	0.003	0.3500	0.359
0.0250	0.003	0.3666	0.356
0.0333	0.006	0.3833	0.356
0.0416	0.006	0.4000	0.353
0.0500	0.012	0.4166	0.350
0.0583	0.015	0.4333	0.346
0.0666	1.592	0.4500	0.343
0.0750	1.640	0.4666	0.343
0.0833	1.482	0.4833	0.340
0.0916	1.308	0.5000	0.337
0.1000	0.627	0.5166	0.337
0.1083	0.044	0.5333	0.334
0.1166	0.589	0.5500	0.334
0.1250	0.428	0.5666	0.331
0.1333	0.403	0.5833	0.328
0.1416	0.406	0.6000	0.328
0.1500	0.400	0.6166	0.324
0.1583	0.397	0.6333	0.324
0.1666	0.394	0.6500	0.321
0.1750	0.391	0.6666	0.321
0.1833	0.391	0.6833	0.318
0.1916	0.387	0.7000	0.318
0.2000	0.387	0.7166	0.315
0.2083	0.384	0.7333	0.315
0.2166	0.381	0.7500	0.315
0.2250	0.381	0.7666	0.312
0.2333	0.381	0.7833	0.309
0.2416	0.378	0.8000	0.309
0.2500	0.378	0.8166	0.305
0.2583	0.375	0.8333	0.305
0.2666	0.375	0.8500	0.302
0.2750	0.372	0.8666	0.302
0.2833	0.372	0.8833	0.302
0.2916	0.369	0.9000	0.299
0.3000	0.369	0.9166	0.299
0.3083	0.365	0.9333	0.299
0.3166	0.365	0.9500	0.296

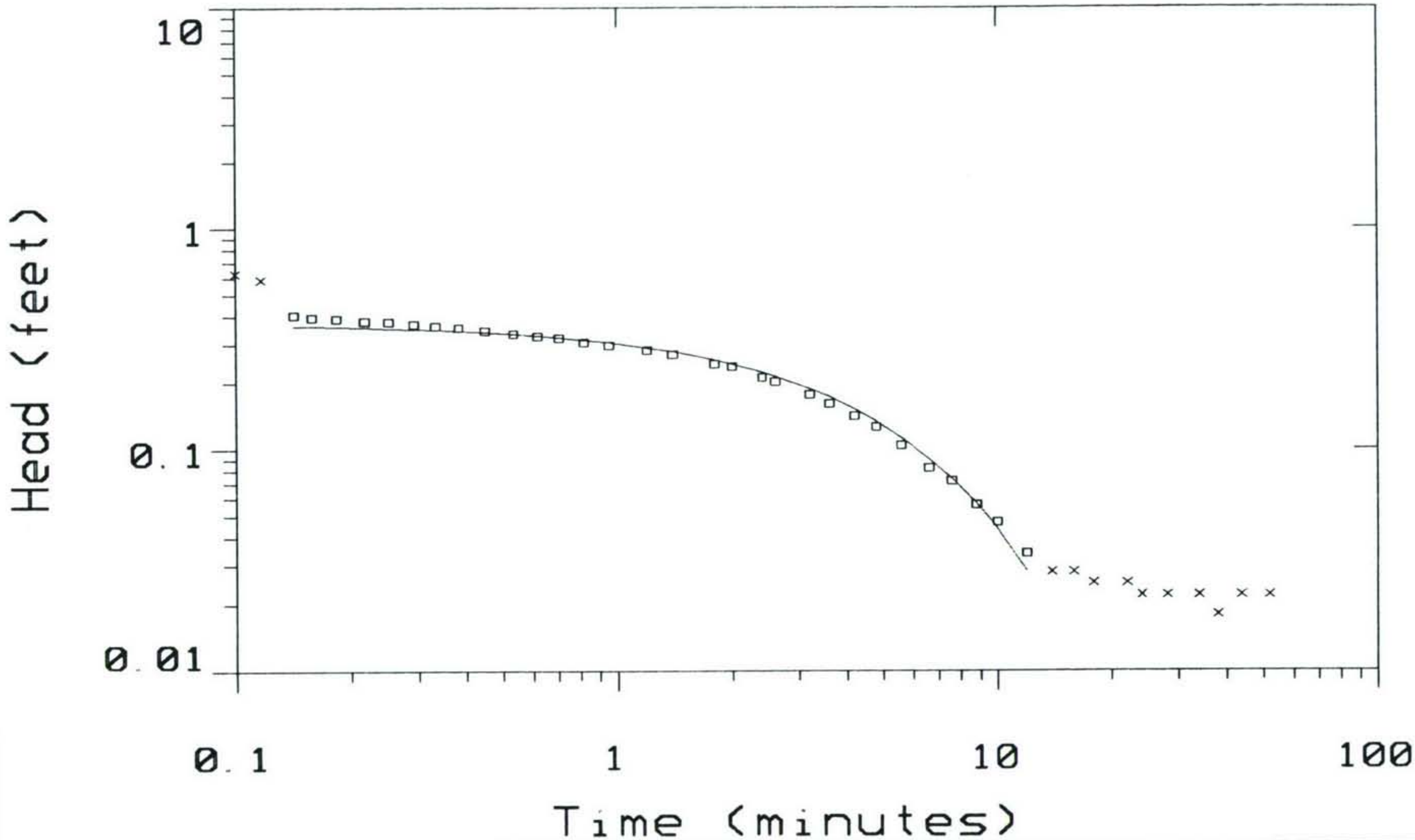
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M01

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:41	Date	09/22 /93
Logger Test	7	INPUT 1 Level (F)	

Step 0 09/22 16:13:25

Elapsed Time	INPUT 1
0.9666	0.296
0.9833	0.293
1.0000	0.293
1.2000	0.280
1.4000	0.268
1.6000	0.255
1.8000	0.242
2.0000	0.236
2.2000	0.220
2.4000	0.211
2.6000	0.201
2.8000	0.195
3.0000	0.186
3.2000	0.176
3.4000	0.173
3.6000	0.160
3.8000	0.154
4.0000	0.148
4.2000	0.141
4.4000	0.135
4.6000	0.129
4.8000	0.126
5.0000	0.119
5.2000	0.113
5.4000	0.110
5.6000	0.104
5.8000	0.100
6.0000	0.097
6.2000	0.094
6.4000	0.088
6.6000	0.082
6.8000	0.085
7.0000	0.078
7.2000	0.078
7.4000	0.072
7.6000	0.072
7.8000	0.069
8.0000	0.047
8.2000	0.094

Elapsed Time	INPUT 1
8.4000	0.072
8.6000	0.056
8.8000	0.056
9.0000	0.047
9.2000	0.050
9.4000	0.050
9.6000	0.050
9.8000	0.047
10.0000	0.047
12.0000	0.034
14.0000	0.028
16.0000	0.028
18.0000	0.025
20.0000	0.025
22.0000	0.025
24.0000	0.022
26.0000	0.022
28.0000	0.022
30.0000	0.022
32.0000	0.025
34.0000	0.022
36.0000	0.022
38.0000	0.018
40.0000	0.022
42.0000	0.022
44.0000	0.022
46.0000	0.022
48.0000	0.022
50.0000	0.022
52.0000	0.022



MODEL TYPE: BOUWER and RICE		for: USAEC	Well Slug Test Data
CONDUCTIVITY: .001275 ft/min		by: Ecology & Environment	Well: E3-P13-M01
TRANSMISSIVITY: .007588 sq. ft/min		WELL DATA: Units: ft	SUDBURY, MA
INITIAL HEAD: 1.640 ft		AQUIFER: Endless	SUDBURY
Data Set: P13M1S0	Date: 09-22-93	THICKNESS: 5.950	
		SCREEN: top: 10.00 base: 20.00	
		DIAMETER: casing: .3400 intake: .3400	
		DEPTH: Water Table: 14.51 TD: 20.46	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M02

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:59	Date	09/23 /93
Logger Test	3	INPUT 1 Level (F)	

Step 0 09/23 11:05:24

Elapsed Time	INPUT 1
0.0000	1.771
0.0083	2.111
0.0166	2.571
0.0250	2.952
0.0333	3.190
0.0416	2.857
0.0500	3.549
0.0583	2.740
0.0666	2.587
0.0750	1.809
0.0833	2.070
0.0916	1.012
0.1000	0.755
0.1083	1.263
0.1166	1.279
0.1250	1.149
0.1333	1.111
0.1416	1.069
0.1500	1.025
0.1583	0.987
0.1666	0.952
0.1750	0.920
0.1833	0.885
0.1916	0.854
0.2000	0.825
0.2083	0.796
0.2166	0.768
0.2250	0.746
0.2333	0.720
0.2416	0.698
0.2500	0.682
0.2583	0.660
0.2666	0.641
0.2750	0.622
0.2833	0.609
0.2916	0.593
0.3000	0.577
0.3083	0.561
0.3166	0.546

Elapsed Time	INPUT 1
0.3250	0.536
0.3333	0.520
0.3500	0.498
0.3666	0.476
0.3833	0.457
0.4000	0.438
0.4166	0.422
0.4333	0.400
0.4500	0.387
0.4666	0.371
0.4833	0.355
0.5000	0.342
0.5166	0.330
0.5333	0.320
0.5500	0.307
0.5666	0.298
0.5833	0.292
0.6000	0.279
0.6166	0.273
0.6333	0.266
0.6500	0.260
0.6666	0.250
0.6833	0.244
0.7000	0.238
0.7166	0.234
0.7333	0.228
0.7500	0.219
0.7666	0.215
0.7833	0.212
0.8000	0.209
0.8166	0.206
0.8333	0.200
0.8500	0.196
0.8666	0.190
0.8833	0.187
0.9000	0.184
0.9166	0.180
0.9333	0.177
0.9500	0.174

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M02

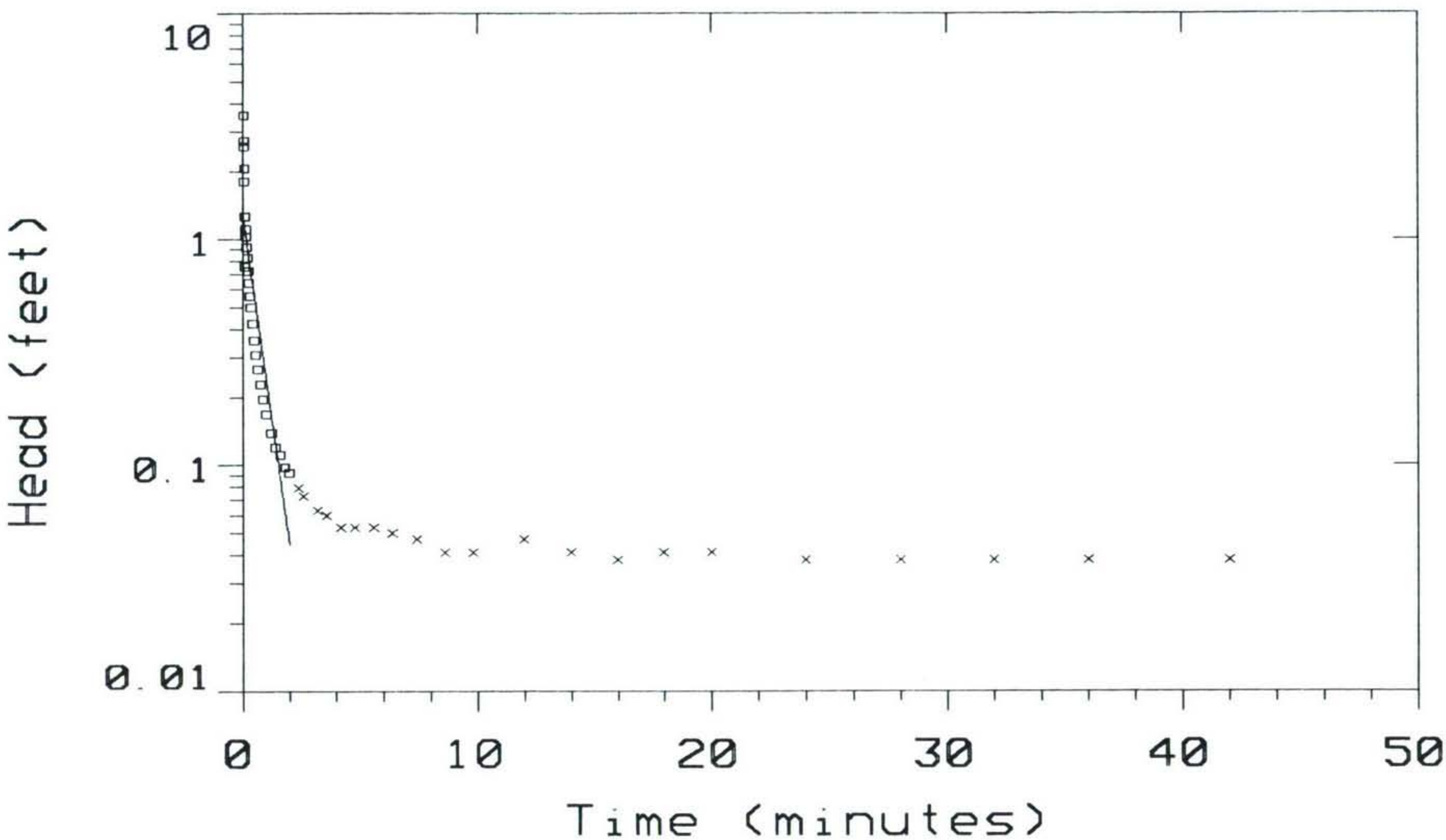
Reference	0.000
SG	1.000
Linearity	0.004
Time	19:59
Logger Test	3

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/23 /93
INPUT 1 Level (F)	

Step 0 09/23 11:05:24

Elapsed Time	INPUT 1
0.9666	0.171
0.9833	0.168
1.0000	0.165
1.2000	0.139
1.4000	0.120
1.6000	0.111
1.8000	0.098
2.0000	0.092
2.2000	0.085
2.4000	0.079
2.6000	0.073
2.8000	0.069
3.0000	0.066
3.2000	0.063
3.4000	0.060
3.6000	0.060
3.8000	0.057
4.0000	0.057
4.2000	0.053
4.4000	0.053
4.6000	0.053
4.8000	0.053
5.0000	0.053
5.2000	0.057
5.4000	0.053
5.6000	0.053
5.8000	0.053
6.0000	0.053
6.2000	0.053
6.4000	0.050
6.6000	0.050
6.8000	0.047
7.0000	0.047
7.2000	0.044
7.4000	0.047
7.6000	0.044
7.8000	0.044
8.0000	0.044
8.2000	0.044

Elapsed Time	INPUT 1
8.4000	0.041
8.6000	0.041
8.8000	0.041
9.0000	0.041
9.2000	0.044
9.4000	0.041
9.6000	0.041
9.8000	0.041
10.0000	0.041
12.0000	0.047
14.0000	0.041
16.0000	0.038
18.0000	0.041
20.0000	0.041
22.0000	0.041
24.0000	0.038
26.0000	0.038
28.0000	0.038
30.0000	0.034
32.0000	0.038
34.0000	0.038
36.0000	0.038
38.0000	0.034
40.0000	0.038
42.0000	0.038



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 009745 ft/min

TRANSMISSIVITY 1381 sq ft/min

INITIAL HEAD 3 549 ft

Data Set P13M2S0 | Date 09-23-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 14 18

SCREEN top 9 000 base 19 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 5 730 TD 19 91

Well Slug Test Data

Well: E3-P13-M02

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M03

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:56	Date	09/23 /93
Logger Test	4	INPUT 1 Level (F)	

Step 0 09/23 13:33:13

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	3.349	0.3250	2.250
0.0083	4.276	0.3333	2.234
0.0166	4.921	0.3500	2.209
0.0250	4.708	0.3666	2.181
0.0333	4.714	0.3833	2.155
0.0416	4.736	0.4000	2.130
0.0500	4.609	0.4166	2.101
0.0583	2.730	0.4333	2.079
0.0666	1.987	0.4500	2.054
0.0750	2.847	0.4666	2.028
0.0833	2.946	0.4833	2.006
0.0916	2.558	0.5000	1.980
0.1000	2.688	0.5166	1.955
0.1083	2.701	0.5333	1.933
0.1166	2.625	0.5500	1.911
0.1250	2.635	0.5666	1.888
0.1333	2.612	0.5833	1.866
0.1416	2.596	0.6000	1.844
0.1500	2.577	0.6166	1.825
0.1583	2.561	0.6333	1.803
0.1666	2.546	0.6500	1.780
0.1750	2.527	0.6666	1.761
0.1833	2.514	0.6833	1.742
0.1916	2.495	0.7000	1.720
0.2000	2.479	0.7166	1.701
0.2083	2.463	0.7333	1.682
0.2166	2.447	0.7500	1.663
0.2250	2.431	0.7666	1.647
0.2333	2.415	0.7833	1.625
0.2416	2.396	0.8000	1.612
0.2500	2.387	0.8166	1.590
0.2583	2.368	0.8333	1.574
0.2666	2.352	0.8500	1.558
0.2750	2.339	0.8666	1.536
0.2833	2.323	0.8833	1.523
0.2916	2.308	0.9000	1.511
0.3000	2.295	0.9166	1.495
0.3083	2.279	0.9333	1.479
0.3166	2.263	0.9500	1.463

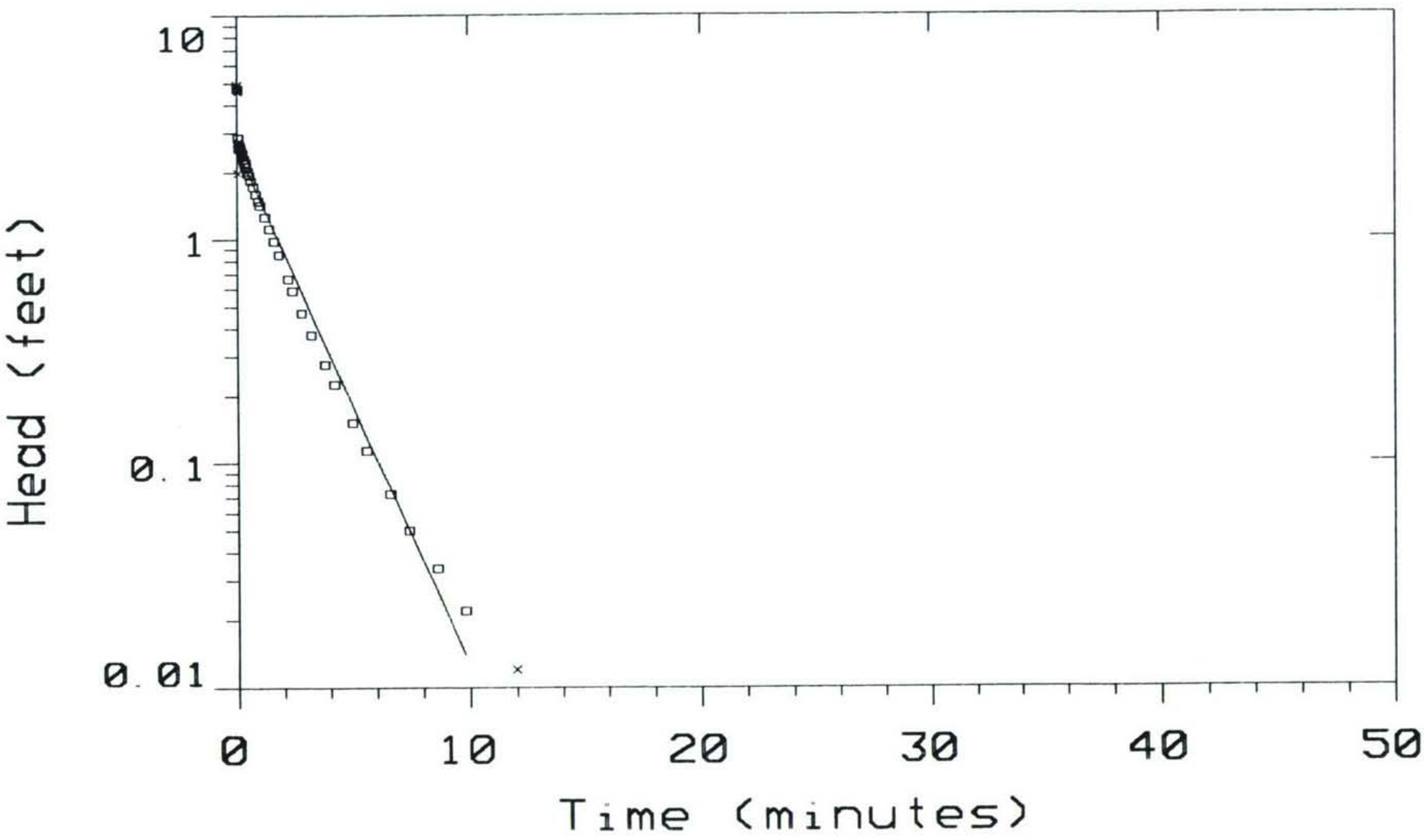
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M03

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:56	Date	09/23 /93
Logger Test	4	INPUT 1 Level (F)	

Step 0 09/23 13:33:13

Elapsed Time	INPUT 1
0.9666	1.447
0.9833	1.438
1.0000	1.422
1.2000	1.257
1.4000	1.111
1.6000	0.977
1.8000	0.853
2.0000	0.755
2.2000	0.666
2.4000	0.590
2.6000	0.523
2.8000	0.469
3.0000	0.415
3.2000	0.374
3.4000	0.342
3.6000	0.304
3.8000	0.276
4.0000	0.247
4.2000	0.225
4.4000	0.203
4.6000	0.184
4.8000	0.168
5.0000	0.152
5.2000	0.139
5.4000	0.126
5.6000	0.114
5.8000	0.104
6.0000	0.095
6.2000	0.085
6.4000	0.079
6.6000	0.073
6.8000	0.066
7.0000	0.063
7.2000	0.057
7.4000	0.050
7.6000	0.050
7.8000	0.044
8.0000	0.044
8.2000	0.041

Elapsed Time	INPUT 1
8.4000	0.034
8.6000	0.034
8.8000	0.031
9.0000	0.031
9.2000	0.028
9.4000	0.025
9.6000	0.025
9.8000	0.022
10.0000	0.022
12.0000	0.012
14.0000	0.006
16.0000	0.003
18.0000	0.003
20.0000	0.003
22.0000	-0.003
24.0000	-0.003
26.0000	0.000
28.0000	-0.003
30.0000	-0.003



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 002561 ft/min

TRANSMISSIVITY 02815 sq ft/min

INITIAL HEAD 4 921 ft

Data Set P13M3S0 | Date 09-23-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 10 99

SCREEN top 8 000 base 18 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 7 670 TD 18 66

Well Slug Test Data

Well: E3-P13-M03

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M04

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:03	Date	09/23 /93
Logger Test	2	INPUT 1 Level (F)	

Step 0 09/23 10:02:01

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.679	0.3250	1.508
0.0083	2.336	0.3333	1.492
0.0166	3.670	0.3500	1.463
0.0250	3.505	0.3666	1.431
0.0333	3.686	0.3833	1.406
0.0416	4.378	0.4000	1.377
0.0500	3.759	0.4166	1.349
0.0583	4.044	0.4333	1.320
0.0666	3.813	0.4500	1.288
0.0750	3.047	0.4666	1.257
0.0833	3.130	0.4833	1.231
0.0916	3.003	0.5000	1.206
0.1000	2.711	0.5166	1.181
0.1083	2.711	0.5333	1.155
0.1166	2.108	0.5500	1.136
0.1250	2.108	0.5666	1.114
0.1333	2.079	0.5833	1.088
0.1416	2.117	0.6000	1.073
0.1500	2.266	0.6166	1.050
0.1583	1.987	0.6333	1.028
0.1666	1.946	0.6500	1.009
0.1750	2.206	0.6666	0.987
0.1833	1.600	0.6833	0.968
0.1916	1.898	0.7000	0.949
0.2000	1.860	0.7166	0.930
0.2083	1.822	0.7333	0.914
0.2166	1.787	0.7500	0.895
0.2250	1.765	0.7666	0.879
0.2333	1.733	0.7833	0.863
0.2416	1.704	0.8000	0.847
0.2500	1.679	0.8166	0.831
0.2583	1.650	0.8333	0.819
0.2666	1.631	0.8500	0.800
0.2750	1.609	0.8666	0.787
0.2833	1.593	0.8833	0.774
0.2916	1.571	0.9000	0.761
0.3000	1.555	0.9166	0.746
0.3083	1.539	0.9333	0.733
0.3166	1.523	0.9500	0.720

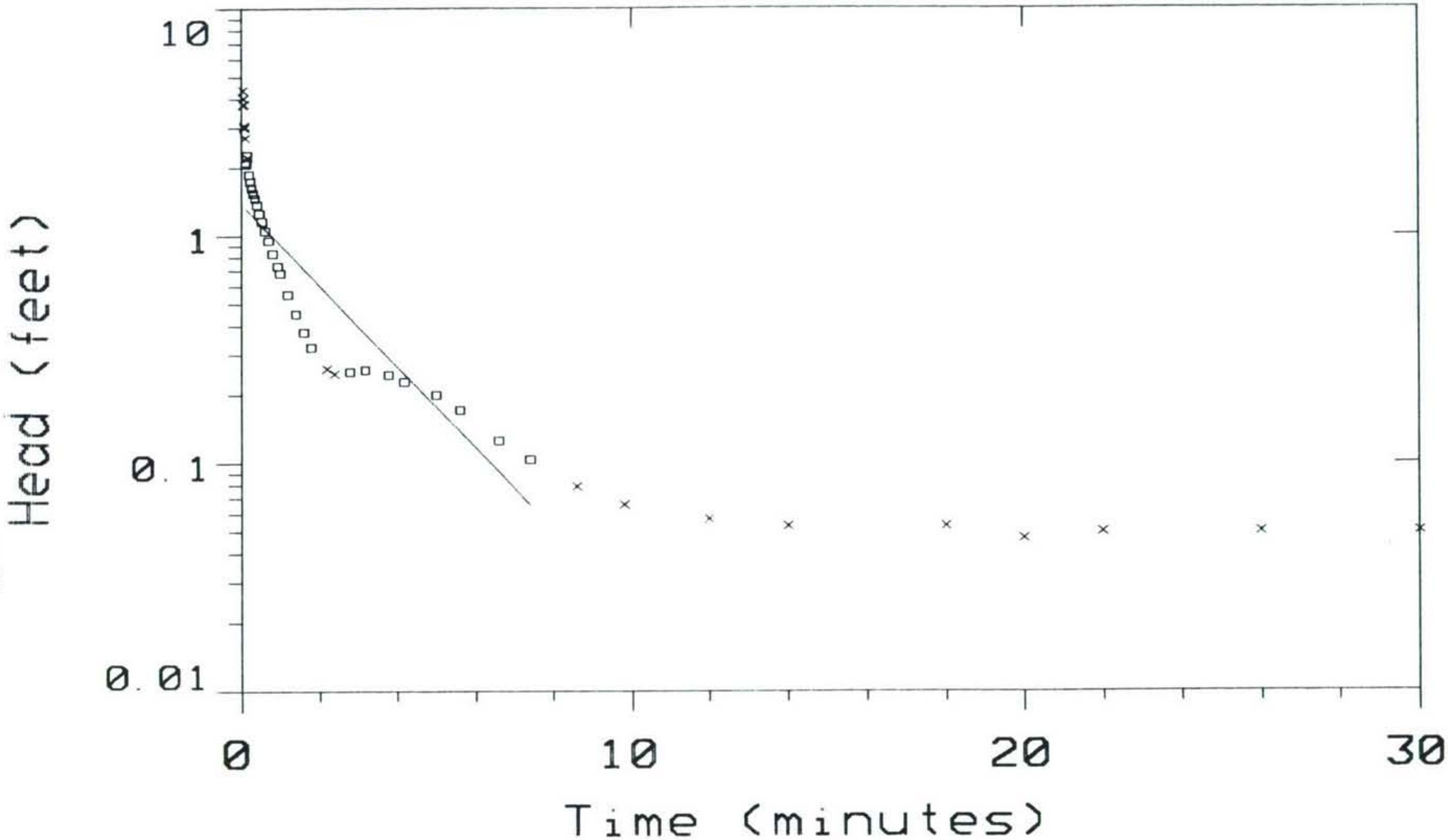
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M04

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	20:03		Date	09/23 /93
Logger Test	2		INPUT 1 Level (F)	

Step 0 09/23 10:02:01

Elapsed Time	INPUT 1
0.9666	0.707
0.9833	0.695
1.0000	0.682
1.2000	0.552
1.4000	0.453
1.6000	0.377
1.8000	0.323
2.0000	0.285
2.2000	0.260
2.4000	0.247
2.6000	0.244
2.8000	0.253
3.0000	0.253
3.2000	0.257
3.4000	0.253
3.6000	0.250
3.8000	0.244
4.0000	0.234
4.2000	0.228
4.4000	0.222
4.6000	0.212
4.8000	0.203
5.0000	0.200
5.2000	0.190
5.4000	0.180
5.6000	0.171
5.8000	0.161
6.0000	0.155
6.2000	0.146
6.4000	0.136
6.6000	0.126
6.8000	0.120
7.0000	0.114
7.2000	0.107
7.4000	0.104
7.6000	0.098
7.8000	0.095
8.0000	0.088
8.2000	0.085

Elapsed Time	INPUT 1
8.4000	0.082
8.6000	0.079
8.8000	0.076
9.0000	0.073
9.2000	0.073
9.4000	0.069
9.6000	0.069
9.8000	0.066
10.0000	0.066
12.0000	0.057
14.0000	0.053
16.0000	0.050
18.0000	0.053
20.0000	0.047
22.0000	0.050
24.0000	0.050
26.0000	0.050
28.0000	0.050
30.0000	0.050



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY .002571 ft/min	
TRANSMISSIVITY .02939 sq. ft/min	
INITIAL HEAD 4.378 ft	
Data Set P13M4S0	Date 9-23-93

for USAEC
by Ecology & Environment
WELL DATA Units ft
AQUIFER Endless
THICKNESS 11.43
SCREEN top 10.00 base 20.00
DIAMETER casing .3400 intake .3400
DEPTH Water Table 8.730 TD 20.16

Well Slug Test Data

Well: E3-P13-M04
SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P22-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:58	Date	09/22 /93
Logger Test	2	INPUT 1 Level (F)	

Step 0 09/22 09:15:10

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.009	0.3250	0.123
0.0083	0.619	0.3333	0.120
0.0166	2.314	0.3500	0.111
0.0250	3.047	0.3666	0.104
0.0333	2.873	0.3833	0.098
0.0416	3.000	0.4000	0.095
0.0500	2.759	0.4166	0.088
0.0583	2.879	0.4333	0.085
0.0666	2.952	0.4500	0.082
0.0750	2.895	0.4666	0.079
0.0833	2.597	0.4833	0.079
0.0916	2.308	0.5000	0.073
0.1000	2.562	0.5166	0.073
0.1083	2.336	0.5333	0.073
0.1166	0.723	0.5500	0.069
0.1250	0.117	0.5666	0.069
0.1333	0.574	0.5833	0.066
0.1416	0.428	0.6000	0.066
0.1500	0.412	0.6166	0.063
0.1583	0.380	0.6333	0.063
0.1666	0.355	0.6500	0.063
0.1750	0.333	0.6666	0.063
0.1833	0.307	0.6833	0.063
0.1916	0.288	0.7000	0.060
0.2000	0.269	0.7166	0.060
0.2083	0.253	0.7333	0.060
0.2166	0.238	0.7500	0.057
0.2250	0.222	0.7666	0.057
0.2333	0.209	0.7833	0.060
0.2416	0.196	0.8000	0.057
0.2500	0.187	0.8166	0.060
0.2583	0.177	0.8333	0.060
0.2666	0.168	0.8500	0.060
0.2750	0.158	0.8666	0.057
0.2833	0.152	0.8833	0.053
0.2916	0.146	0.9000	0.057
0.3000	0.139	0.9166	0.053
0.3083	0.133	0.9333	0.053
0.3166	0.130	0.9500	0.053

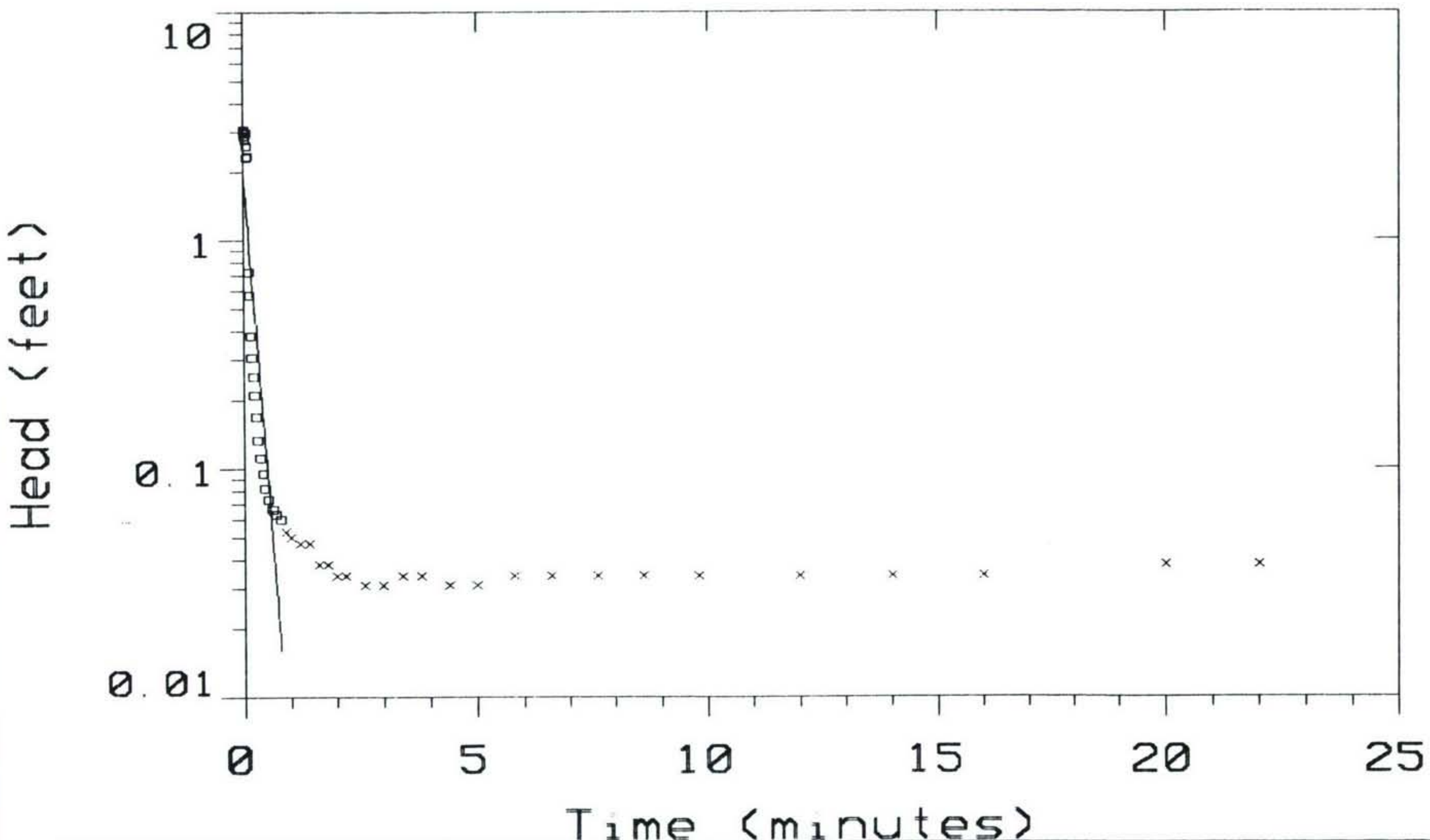
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P22-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:58	Date	09/22 /93
Logger Test	2	INPUT 1 Level (F)	

Step 0 09/22 09:15:10

Elapsed Time	INPUT 1
0.9666	0.053
0.9833	0.053
1.0000	0.050
1.2000	0.047
1.4000	0.047
1.6000	0.038
1.8000	0.038
2.0000	0.034
2.2000	0.034
2.4000	0.034
2.6000	0.031
2.8000	0.031
3.0000	0.031
3.2000	0.031
3.4000	0.034
3.6000	0.031
3.8000	0.034
4.0000	0.034
4.2000	0.031
4.4000	0.031
4.6000	0.031
4.8000	0.031
5.0000	0.031
5.2000	0.034
5.4000	0.034
5.6000	0.034
5.8000	0.034
6.0000	0.034
6.2000	0.034
6.4000	0.034
6.6000	0.034
6.8000	0.034
7.0000	0.034
7.2000	0.034
7.4000	0.034
7.6000	0.034
7.8000	0.034
8.0000	0.034
8.2000	0.034

Elapsed Time	INPUT 1
8.4000	0.034
8.6000	0.034
8.8000	0.034
9.0000	0.034
9.2000	0.034
9.4000	0.034
9.6000	0.034
9.8000	0.034
10.0000	0.034
12.0000	0.034
14.0000	0.034
16.0000	0.034
18.0000	0.034
20.0000	0.038
22.0000	0.038



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 03158 ft/min	by Ecology & Environment	Well: E3-P22-M01
TRANSMISSIVITY 3922 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 3 047 ft	AQUIFER Endless	SUDBURY
Data Set P22M1S0	THICKNESS 12 42	
Date 9-22-93	SCREEN top 10 00 base 20 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 7 490 TD 19 91	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P23-M01

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:44	Date	09/22 /93
Logger Test	6	INPUT 1	Level (F)

Step 0 09/22 14:54:36

Elapsed Time	INPUT 1
0.0000	0.006
0.0083	0.006
0.0166	0.009
0.0250	0.009
0.0333	0.009
0.0416	0.015
0.0500	0.507
0.0583	0.725
0.0666	0.879
0.0750	0.892
0.0833	0.946
0.0916	0.801
0.1000	0.971
0.1083	1.012
0.1166	0.488
0.1250	-0.009
0.1333	0.220
0.1416	0.198
0.1500	0.189
0.1583	0.179
0.1666	0.173
0.1750	0.167
0.1833	0.160
0.1916	0.151
0.2000	0.148
0.2083	0.145
0.2166	0.138
0.2250	0.135
0.2333	0.129
0.2416	0.126
0.2500	0.123
0.2583	0.116
0.2666	0.113
0.2750	0.110
0.2833	0.107
0.2916	0.104
0.3000	0.097
0.3083	0.094
0.3166	0.091

Elapsed Time	INPUT 1
0.3250	0.091
0.3333	0.085
0.3500	0.082
0.3666	0.075
0.3833	0.072
0.4000	0.069
0.4166	0.063
0.4333	0.059
0.4500	0.056
0.4666	0.053
0.4833	0.050
0.5000	0.047
0.5166	0.047
0.5333	0.044
0.5500	0.044
0.5666	0.041
0.5833	0.037
0.6000	0.037
0.6166	0.034
0.6333	0.034
0.6500	0.034
0.6666	0.031
0.6833	0.031
0.7000	0.031
0.7166	0.028
0.7333	0.028
0.7500	0.028
0.7666	0.028
0.7833	0.025
0.8000	0.025
0.8166	0.025
0.8333	0.022
0.8500	0.022
0.8666	0.022
0.8833	0.022
0.9000	0.022
0.9166	0.022
0.9333	0.022
0.9500	0.018

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P23-M01

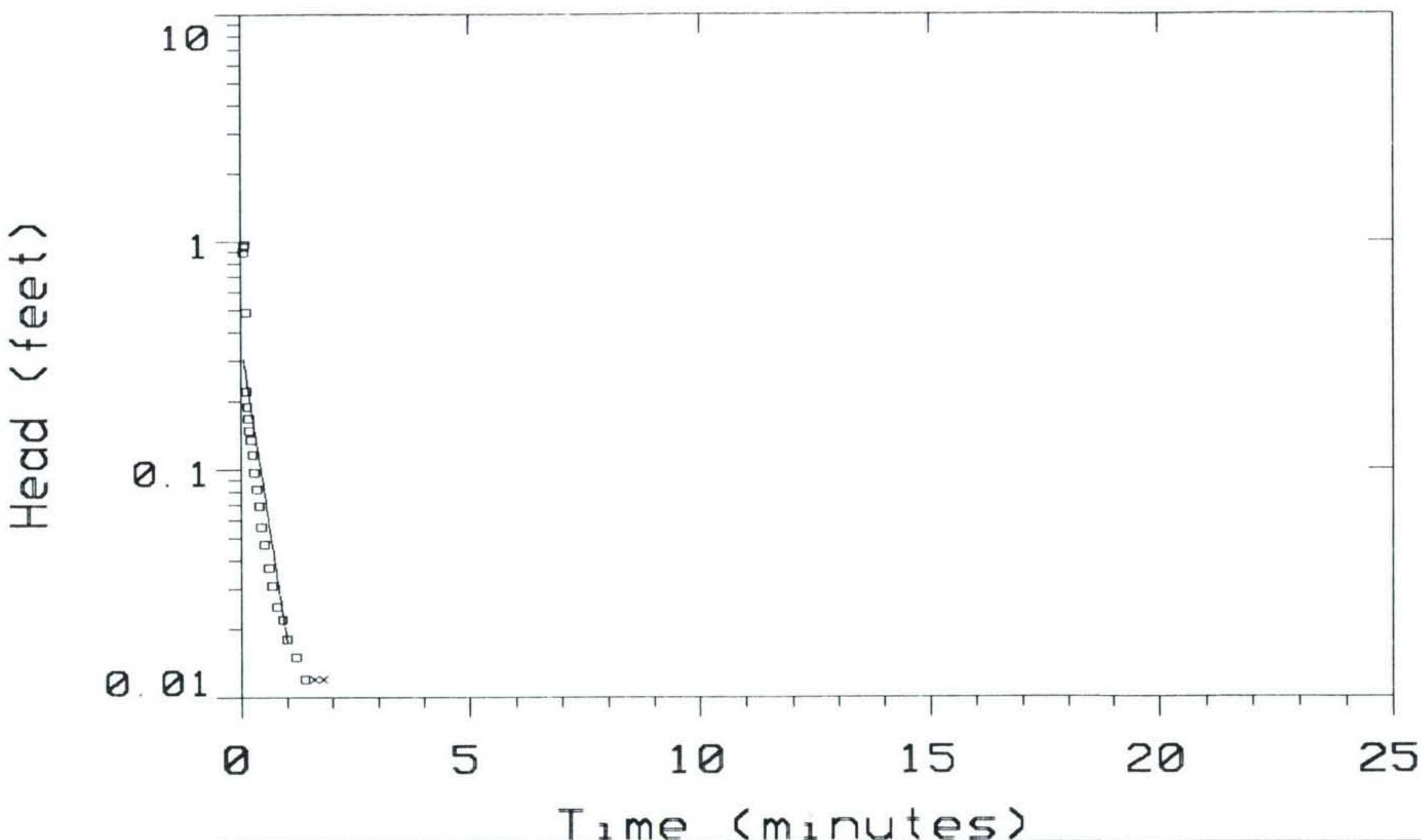
Reference	0.000
SG	1.000
Linearity	-0.000
Time	19:44
Logger Test	6

Scale Factor	9.990
Offset	-0.009
Delay mSEC	50.000
Date	09/22 /93
INPUT 1 Level (F)	

Step 0 09/22 14:54:36

Elapsed Time	INPUT 1
0.9666	0.018
0.9833	0.018
1.0000	0.018
1.2000	0.015
1.4000	0.012
1.6000	0.012
1.8000	0.012
2.0000	0.009
2.2000	0.009
2.4000	0.009
2.6000	0.009
2.8000	0.009
3.0000	0.009
3.2000	0.009
3.4000	0.009
3.6000	0.009
3.8000	0.009
4.0000	0.009
4.2000	0.006
4.4000	0.006
4.6000	0.006
4.8000	0.006
5.0000	0.006
5.2000	0.006
5.4000	0.006
5.6000	0.006
5.8000	0.006
6.0000	0.006
6.2000	0.006
6.4000	0.006
6.6000	0.006
6.8000	0.009
7.0000	0.006
7.2000	0.006
7.4000	0.006
7.6000	0.003
7.8000	0.006
8.0000	0.006
8.2000	0.006

Elapsed Time	INPUT 1
8.4000	0.006
8.6000	0.006
8.8000	0.006
9.0000	0.006
9.2000	0.006
9.4000	0.006
9.6000	0.006
9.8000	0.006
10.0000	0.006
12.0000	0.006
14.0000	0.003
16.0000	0.003
18.0000	0.003
20.0000	0.003
22.0000	0.003
24.0000	0.003
26.0000	0.003
28.0000	0.003



MODEL TYPE BOUWER and RICE

CONDUCTIVITY .01371 ft/min

TRANSMISSIVITY .09241 sq ft/min

INITIAL HEAD .8920 ft

Data Set P23MIS0 | Date 9-22-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 6.740

SCREEN top 10.00 base 20.00

DIAMETER casing .3400 intake .3400

DEPTH Water Table 14.44 TD 21.18

Well Slug Test Data

Well: E3-P23-M01

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M01

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	11:50		Date	09/24 /93
Logger Test	2		INPUT 1 Level (F)	

Step 1 09/24 10:19:36

Elapsed Time	INPUT 1
0.0000	-2.911
0.0083	-2.822
0.0166	-2.736
0.0250	-2.653
0.0333	-2.577
0.0416	-2.504
0.0500	-2.447
0.0583	-2.387
0.0666	-2.317
0.0750	-2.250
0.0833	-2.187
0.0916	-2.123
0.1000	-2.066
0.1083	-2.009
0.1166	-1.955
0.1250	-1.914
0.1333	-1.869
0.1416	-1.819
0.1500	-1.771
0.1583	-1.723
0.1666	-1.679
0.1750	-1.638
0.1833	-1.584
0.1916	-1.568
0.2000	-1.565
0.2083	-1.533
0.2166	-1.495
0.2250	-1.460
0.2333	-1.422
0.2416	-1.387
0.2500	-1.355
0.2583	-1.323
0.2666	-1.288
0.2750	-1.257
0.2833	-1.228
0.2916	-1.200
0.3000	-1.171
0.3083	-1.146
0.3166	-1.117

Elapsed Time	INPUT 1
0.3250	-1.088
0.3333	-1.063
0.3500	-1.015
0.3666	-0.971
0.3833	-0.923
0.4000	-0.885
0.4166	-0.844
0.4333	-0.806
0.4500	-0.771
0.4666	-0.739
0.4833	-0.707
0.5000	-0.679
0.5166	-0.647
0.5333	-0.622
0.5500	-0.596
0.5666	-0.574
0.5833	-0.549
0.6000	-0.530
0.6166	-0.507
0.6333	-0.488
0.6500	-0.469
0.6666	-0.453
0.6833	-0.434
0.7000	-0.419
0.7166	-0.406
0.7333	-0.390
0.7500	-0.377
0.7666	-0.365
0.7833	-0.352
0.8000	-0.339
0.8166	-0.330
0.8333	-0.317
0.8500	-0.307
0.8666	-0.298
0.8833	-0.288
0.9000	-0.279
0.9166	-0.269
0.9333	-0.266
0.9500	-0.257

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M01

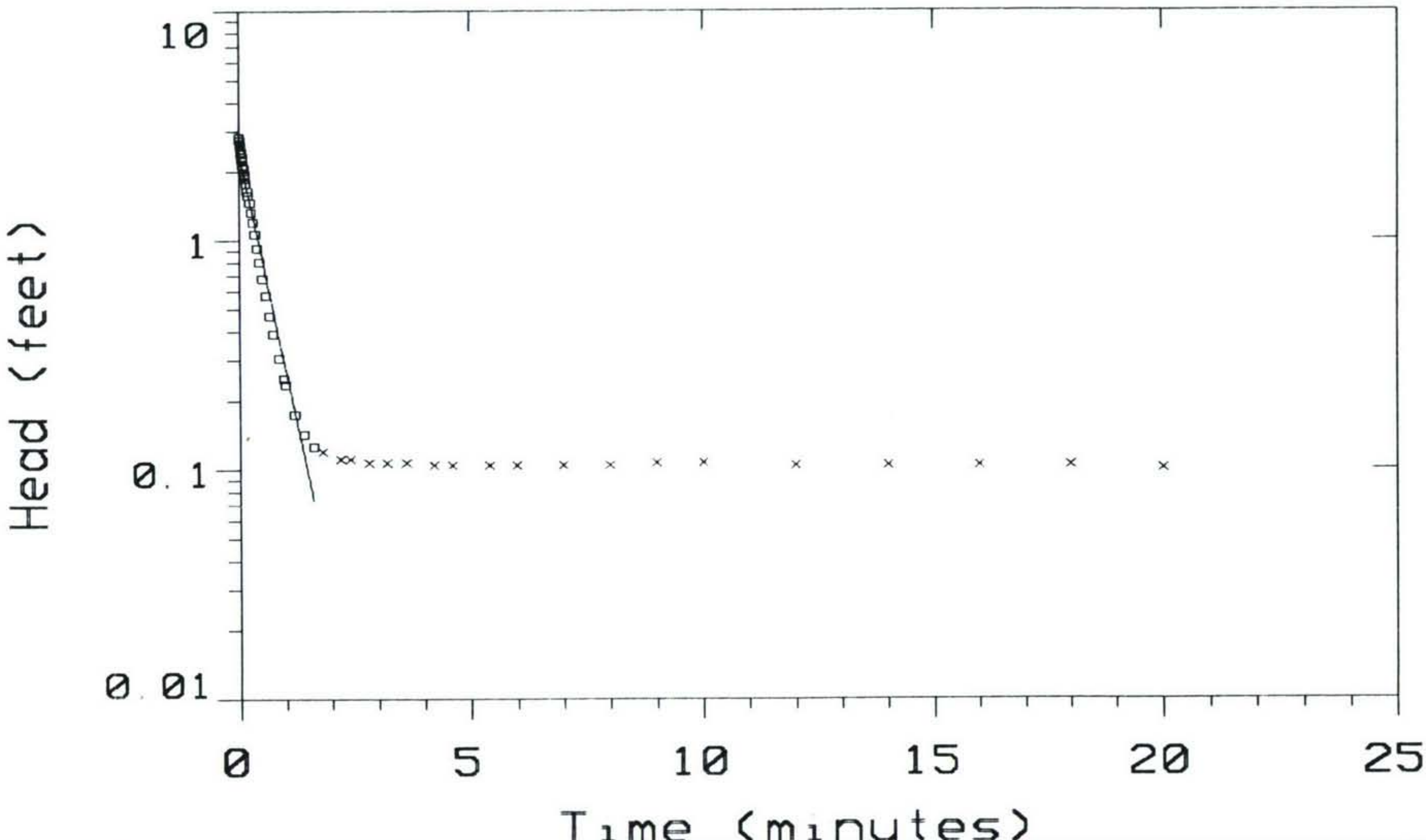
Reference	0.000
SG	1.000
Linearity	0.004
Time	11:50
Logger Test	2

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/24 /93
INPUT 1	Level (F)

Step 1 09/24 10:19:36

Elapsed Time	INPUT 1
0.9666	-0.250
0.9833	-0.241
1.0000	-0.234
1.2000	-0.174
1.4000	-0.142
1.6000	-0.126
1.8000	-0.120
2.0000	-0.114
2.2000	-0.111
2.4000	-0.111
2.6000	-0.107
2.8000	-0.107
3.0000	-0.107
3.2000	-0.107
3.4000	-0.107
3.6000	-0.107
3.8000	-0.107
4.0000	-0.107
4.2000	-0.104
4.4000	-0.104
4.6000	-0.104
4.8000	-0.104
5.0000	-0.104
5.2000	-0.101
5.4000	-0.104
5.6000	-0.104
5.8000	-0.104
6.0000	-0.104
6.2000	-0.104
6.4000	-0.104
6.6000	-0.104
6.8000	-0.101
7.0000	-0.104
7.2000	-0.104
7.4000	-0.107
7.6000	-0.107
7.8000	-0.104
8.0000	-0.104
8.2000	-0.107

Elapsed Time	INPUT 1
8.4000	-0.104
8.6000	-0.104
8.8000	-0.104
9.0000	-0.107
9.2000	-0.101
9.4000	-0.104
9.6000	-0.104
9.8000	-0.107
10.0000	-0.107
12.0000	-0.104
14.0000	-0.104
16.0000	-0.104
18.0000	-0.104
20.0000	-0.101



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY .009687 ft/min	by Ecology & Environment	Well: E3-P26-M01
TRANSMISSIVITY .1275 sq. ft/min	WELL DATA Units: ft	SUDBURY, MA
INITIAL HEAD 2.822 ft	AQUIFER Endless	SUDBURY
Data Set P26M1S0 Date 9-24-93	THICKNESS 13.17	
	SCREEN top 10.00 base 20.00	
	DIAMETER casing .3400 intake .3400	
	DEPTH Water Table 8.630 TD 21.80	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M02

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	11:53	Date	09/24 /93
Logger Test	1	INPUT 1 Level (F)	

Step 0 09/24 07:53:56

Elapsed Time	INPUT 1
0.0000	4.546
0.0083	4.724
0.0166	5.191
0.0250	4.978
0.0333	4.807
0.0416	4.784
0.0500	4.708
0.0583	4.003
0.0666	2.562
0.0750	2.228
0.0833	3.044
0.0916	2.730
0.1000	2.787
0.1083	2.765
0.1166	2.663
0.1250	2.647
0.1333	2.612
0.1416	2.543
0.1500	2.530
0.1583	2.492
0.1666	2.454
0.1750	2.378
0.1833	2.358
0.1916	2.330
0.2000	2.282
0.2083	2.247
0.2166	2.203
0.2250	2.168
0.2333	2.133
0.2416	2.101
0.2500	2.066
0.2583	2.031
0.2666	1.997
0.2750	1.968
0.2833	1.939
0.2916	1.911
0.3000	1.885
0.3083	1.854
0.3166	1.828

Elapsed Time	INPUT 1
0.3250	1.803
0.3333	1.774
0.3500	1.727
0.3666	1.679
0.3833	1.635
0.4000	1.587
0.4166	1.542
0.4333	1.498
0.4500	1.460
0.4666	1.419
0.4833	1.377
0.5000	1.339
0.5166	1.304
0.5333	1.266
0.5500	1.235
0.5666	1.203
0.5833	1.171
0.6000	1.136
0.6166	1.108
0.6333	1.079
0.6500	1.050
0.6666	1.028
0.6833	1.003
0.7000	0.977
0.7166	0.955
0.7333	0.936
0.7500	0.914
0.7666	0.895
0.7833	0.873
0.8000	0.854
0.8166	0.838
0.8333	0.815
0.8500	0.800
0.8666	0.784
0.8833	0.768
0.9000	0.752
0.9166	0.742
0.9333	0.730
0.9500	0.720

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M02

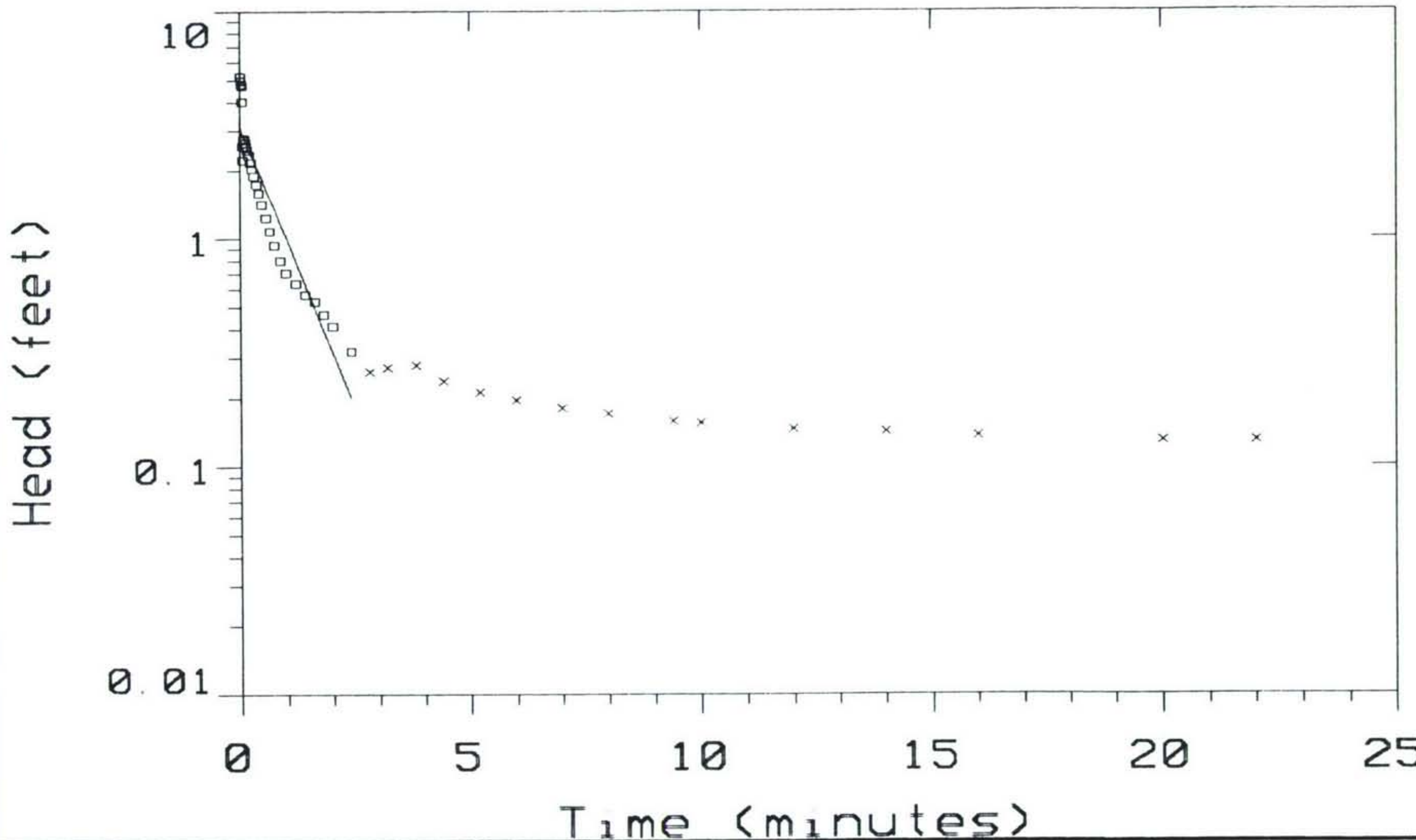
Reference	0.000
SG	1.000
Linearity	0.004
Time	11:53
Logger Test	1

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/24 /93
INPUT 1	Level (F)

Step 0 09/24 07:53:56

Elapsed Time	INPUT 1
0.9666	0.714
0.9833	0.704
1.0000	0.698
1.2000	0.634
1.4000	0.568
1.6000	0.530
1.8000	0.466
2.0000	0.412
2.2000	0.358
2.4000	0.320
2.6000	0.282
2.8000	0.260
3.0000	0.260
3.2000	0.273
3.4000	0.288
3.6000	0.301
3.8000	0.279
4.0000	0.263
4.2000	0.247
4.4000	0.238
4.6000	0.234
4.8000	0.222
5.0000	0.219
5.2000	0.212
5.4000	0.206
5.6000	0.209
5.8000	0.200
6.0000	0.196
6.2000	0.193
6.4000	0.190
6.6000	0.187
6.8000	0.184
7.0000	0.180
7.2000	0.180
7.4000	0.177
7.6000	0.174
7.8000	0.174
8.0000	0.171
8.2000	0.168

Elapsed Time	INPUT 1
8.4000	0.168
8.6000	0.168
8.8000	0.165
9.0000	0.161
9.2000	0.161
9.4000	0.158
9.6000	0.161
9.8000	0.158
10.0000	0.155
12.0000	0.146
14.0000	0.142
16.0000	0.136
18.0000	0.133
20.0000	0.130
22.0000	0.130
24.0000	0.126
26.0000	0.126
28.0000	0.123
30.0000	0.123
32.0000	0.120
34.0000	0.120
36.0000	0.120
38.0000	0.117
40.0000	0.117
42.0000	0.117
44.0000	0.117
46.0000	0.117
48.0000	0.117
50.0000	0.117
52.0000	0.117
54.0000	0.117
56.0000	0.117



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 006009 ft/min

TRANSMISSIVITY 07523 sq ft/min

INITIAL HEAD 5 191 ft

Data Set P26M2S0 Date 9-24-93

for: USAEC

by: Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 12 52

SCREEN top 10 00 base 20 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 8 050 TD 20 57

Well Slug Test Data

Well: E3-P26-M02

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M03

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:08	Date	09/23 /93
Logger Test	6	INPUT 1 Level (F)	

Step 0 09/23 16:25:29

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	3.070	0.3250	2.435
0.0083	4.000	0.3333	2.425
0.0166	4.660	0.3500	2.409
0.0250	4.835	0.3666	2.390
0.0333	4.879	0.3833	2.374
0.0416	4.933	0.4000	2.355
0.0500	4.892	0.4166	2.339
0.0583	4.911	0.4333	2.320
0.0666	4.844	0.4500	2.308
0.0750	3.597	0.4666	2.295
0.0833	2.171	0.4833	2.279
0.0916	2.492	0.5000	2.266
0.1000	3.073	0.5166	2.250
0.1083	2.666	0.5333	2.238
0.1166	2.708	0.5500	2.225
0.1250	2.781	0.5666	2.216
0.1333	2.695	0.5833	2.203
0.1416	2.698	0.6000	2.190
0.1500	2.692	0.6166	2.177
0.1583	2.663	0.6333	2.171
0.1666	2.654	0.6500	2.152
0.1750	2.647	0.6666	2.142
0.1833	2.631	0.6833	2.133
0.1916	2.622	0.7000	2.108
0.2000	2.603	0.7166	2.095
0.2083	2.593	0.7333	2.082
0.2166	2.584	0.7500	2.069
0.2250	2.568	0.7666	2.063
0.2333	2.558	0.7833	2.050
0.2416	2.543	0.8000	2.041
0.2500	2.533	0.8166	2.031
0.2583	2.517	0.8333	2.022
0.2666	2.508	0.8500	2.012
0.2750	2.501	0.8666	2.003
0.2833	2.485	0.8833	1.993
0.2916	2.476	0.9000	1.981
0.3000	2.463	0.9166	1.974
0.3083	2.457	0.9333	1.965
0.3166	2.447	0.9500	1.955

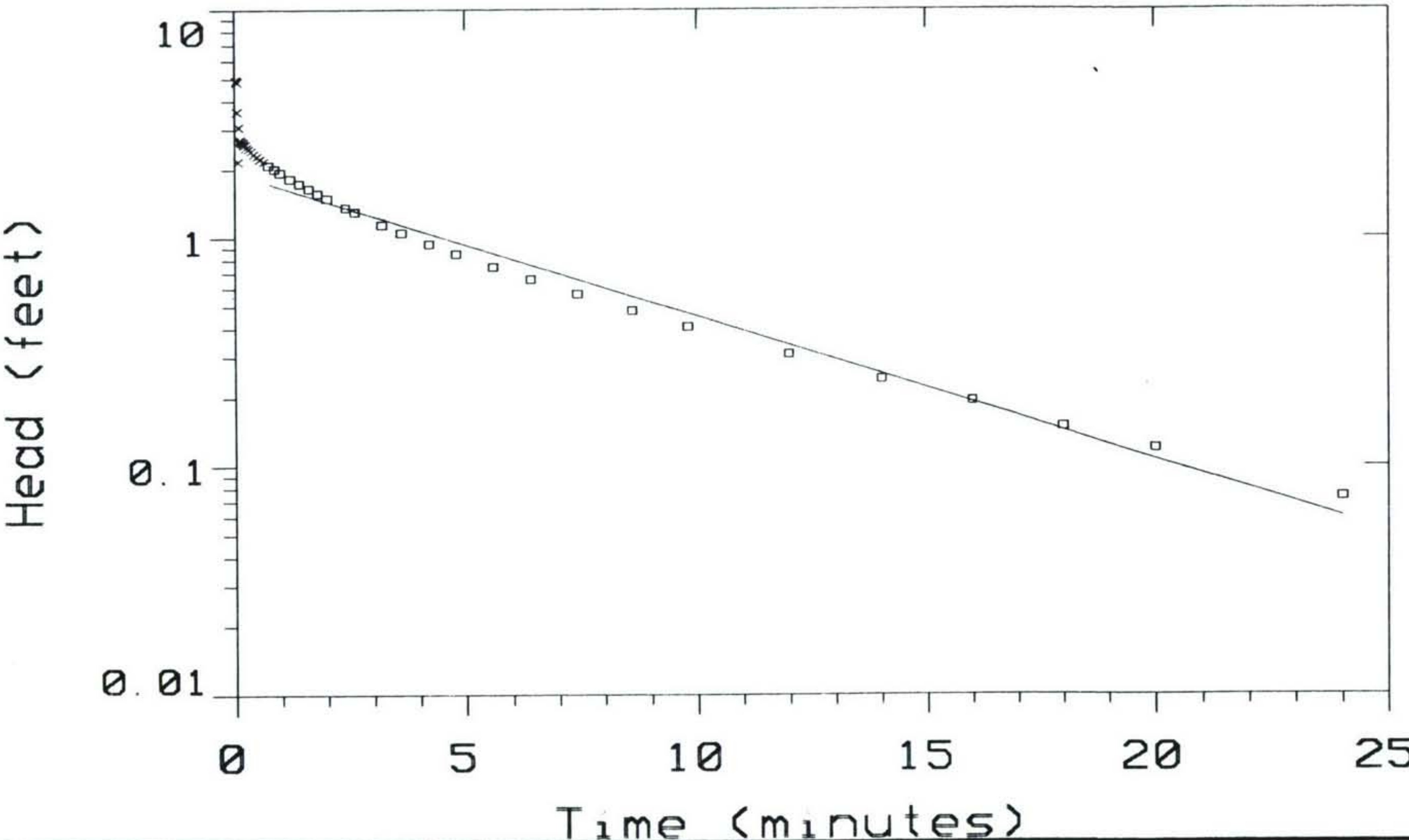
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M03

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	19:08		Date	09/23 /93
Logger Test	6		INPUT 1 Level (F)	

Step 0 09/23 16:25:29

Elapsed Time	INPUT 1
0.9666	1.946
0.9833	1.936
1.0000	1.930
1.2000	1.822
1.4000	1.730
1.6000	1.644
1.8000	1.565
2.0000	1.492
2.2000	1.422
2.4000	1.361
2.6000	1.301
2.8000	1.244
3.0000	1.190
3.2000	1.142
3.4000	1.095
3.6000	1.050
3.8000	1.012
4.0000	0.974
4.2000	0.942
4.4000	0.911
4.6000	0.879
4.8000	0.850
5.0000	0.822
5.2000	0.796
5.4000	0.771
5.6000	0.746
5.8000	0.723
6.0000	0.701
6.2000	0.679
6.4000	0.660
6.6000	0.638
6.8000	0.619
7.0000	0.603
7.2000	0.584
7.4000	0.568
7.6000	0.552
7.8000	0.536
8.0000	0.520
8.2000	0.504

Elapsed Time	INPUT 1
8.4000	0.492
8.6000	0.479
8.8000	0.466
9.0000	0.453
9.2000	0.438
9.4000	0.428
9.6000	0.422
9.8000	0.409
10.0000	0.400
12.0000	0.311
14.0000	0.241
16.0000	0.193
18.0000	0.149
20.0000	0.120
22.0000	0.092
24.0000	0.073
26.0000	0.060
28.0000	0.047
30.0000	0.038
32.0000	0.028
34.0000	0.022
36.0000	0.015
38.0000	0.012
40.0000	0.009
42.0000	0.006



MODEL TYPE: BOUWER and RICE	for: USAEC	Well Slug Test Data
CONDUCTIVITY: .0008296 ft/min	by: Ecology & Environment	Well: E3-P26-M03
TRANSMISSIVITY: .009731 sq. ft/min	WELL DATA: Units: ft	SUDBURY, MA
INITIAL HEAD: 4.933 ft	AQUIFER: Endless	SUDBURY
Data Set: P26M3S0	THICKNESS: 11.73	
Date: 9-23-93	SCREEN: top 10.00 base 20.00	
	DIAMETER: casing .3400 intake .3400	
	DEPTH: Water Table 8.480 TD 20.21	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P31-M01

Reference	0.000
SG	1.000
Linearity	0.009
Time	21:30
Logger Test	1

Scale Factor	10.012
Offset	-0.042
Delay mSEC	50.000
Date	09/21 /93
INPUT 3	Level (F)

Step 0 09/21 08:59:16

Elapsed Time	INPUT 3
0.0000	0.018
0.0083	0.012
0.0166	0.015
0.0250	0.018
0.0333	0.022
0.0416	1.296
0.0500	3.036
0.0583	1.667
0.0666	1.379
0.0750	1.078
0.0833	1.885
0.0916	1.831
0.1000	1.512
0.1083	1.739
0.1166	1.625
0.1250	1.584
0.1333	1.600
0.1416	1.559
0.1500	1.534
0.1583	1.518
0.1666	1.493
0.1750	1.470
0.1833	1.455
0.1916	1.432
0.2000	1.413
0.2083	1.395
0.2166	1.376
0.2250	1.357
0.2333	1.341
0.2416	1.325
0.2500	1.306
0.2583	1.290
0.2666	1.274
0.2750	1.258
0.2833	1.243
0.2916	1.230
0.3000	1.217
0.3083	1.208
0.3166	1.183

Elapsed Time	INPUT 3
0.3250	1.192
0.3333	1.170
0.3500	1.160
0.3666	1.103
0.3833	1.015
0.4000	1.132
0.4166	1.075
0.4333	1.081
0.4500	0.958
0.4666	0.993
0.4833	0.952
0.5000	0.939
0.5166	0.917
0.5333	0.901
0.5500	0.885
0.5666	0.866
0.5833	0.850
0.6000	0.835
0.6166	0.822
0.6333	0.806
0.6500	0.790
0.6666	0.778
0.6833	0.765
0.7000	0.749
0.7166	0.740
0.7333	0.727
0.7500	0.714
0.7666	0.702
0.7833	0.692
0.8000	0.683
0.8166	0.673
0.8333	0.664
0.8500	0.654
0.8666	0.645
0.8833	0.635
0.9000	0.629
0.9166	0.619
0.9333	0.613
0.9500	0.607

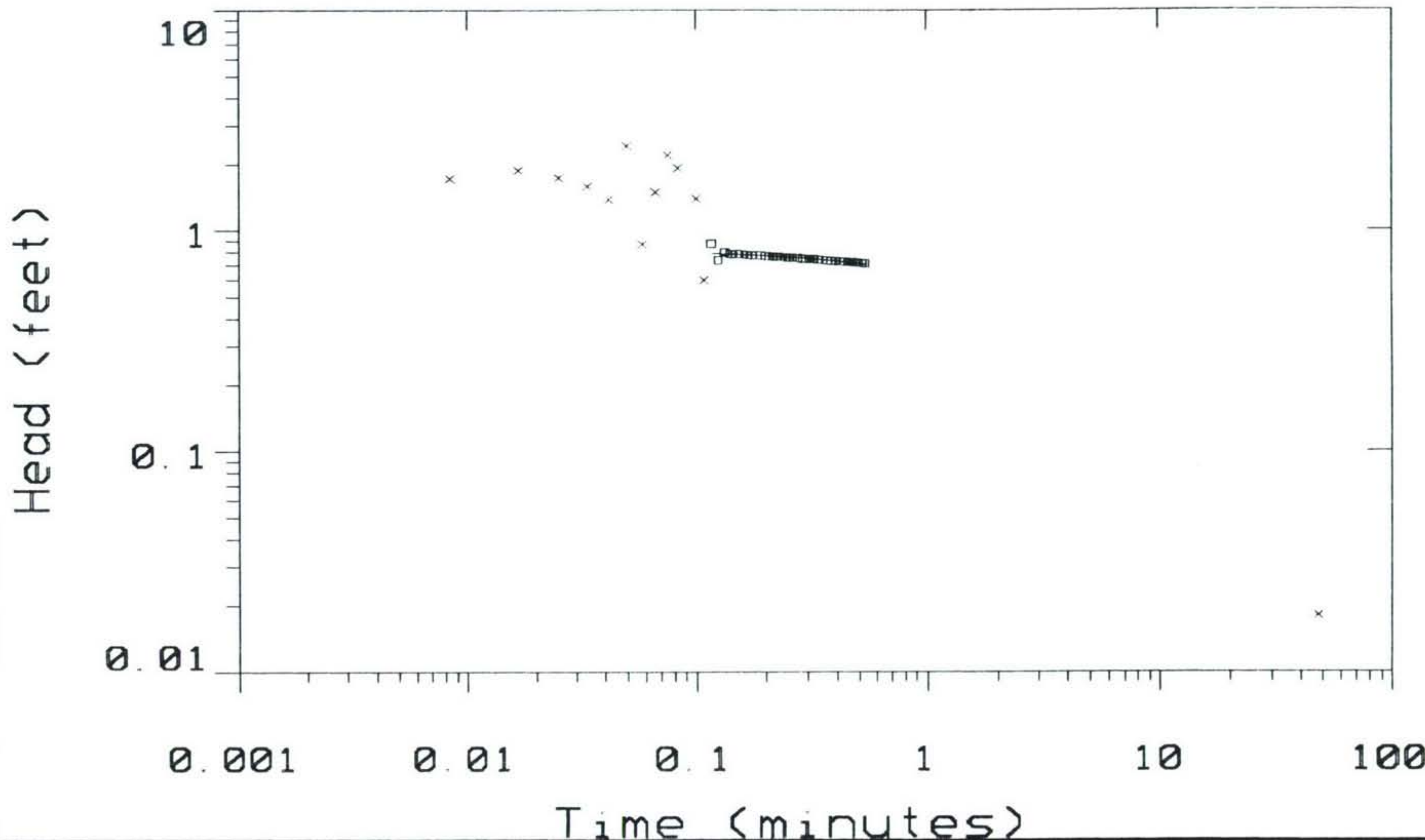
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P31-M01

Reference	0.000		Scale Factor	10.012
SG	1.000		Offset	-0.042
Linearity	0.009		Delay mSEC	50.000
Time	21:30		Date	09/21 /93
Logger Test	1		INPUT 3 Level (F)	

Step 0 09/21 08:59:16

Elapsed Time	INPUT 3
0.9666	0.601
0.9833	0.591
1.0000	0.585
1.2000	0.528
1.4000	0.493
1.6000	0.471
1.8000	0.455
2.0000	0.446
2.2000	0.430
2.4000	0.417
2.6000	0.408
2.8000	0.398
3.0000	0.389
3.2000	0.382
3.4000	0.373
3.6000	0.366
3.8000	0.360
4.0000	0.354
4.2000	0.351
4.4000	0.347
4.6000	0.341
4.8000	0.338
5.0000	0.335
5.2000	0.332
5.4000	0.328
5.6000	0.325
5.8000	0.322
6.0000	0.322
6.2000	0.319
6.4000	0.316
6.6000	0.313
6.8000	0.309
7.0000	0.306
7.2000	0.306
7.4000	0.303
7.6000	0.303
7.8000	0.300
8.0000	0.297
8.2000	0.294

Elapsed Time	INPUT 3
8.4000	0.294
8.6000	0.291
8.8000	0.287
9.0000	0.284
9.2000	0.281
9.4000	0.281
9.6000	0.278
9.8000	0.275
10.0000	0.275
12.0000	0.256
14.0000	0.237
16.0000	0.221
18.0000	0.208
20.0000	0.192
22.0000	0.183
24.0000	0.167
26.0000	0.158
28.0000	0.148
30.0000	0.139
32.0000	0.132
34.0000	0.126
36.0000	0.117
38.0000	0.110
40.0000	0.104
42.0000	0.098
44.0000	0.091
46.0000	0.088
48.0000	0.082



MODEL TYPE: BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY: .006760 ft/min	by Ecology & Environment	Well: E3-P31-M01
TRANSMISSIVITY: .07240 sq. ft/min	WELL DATA Units: ft	SUDBURY, MA
INITIAL HEAD: 1.720 ft	AQUIFER: Endless	SUDBURY
Data Set: P31S0	THICKNESS: 10.71	
Date: 9-21-93	SCREEN: top 8.000 base 18.00	
	DIAMETER: casing .3400 intake .3400	
	DEPTH: Water Table 9.360 TD 20.09	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:10	Date	09/21 /93
Logger Test	4	INPUT 1 Level (F)	

Step 0 09/21 14:36:52

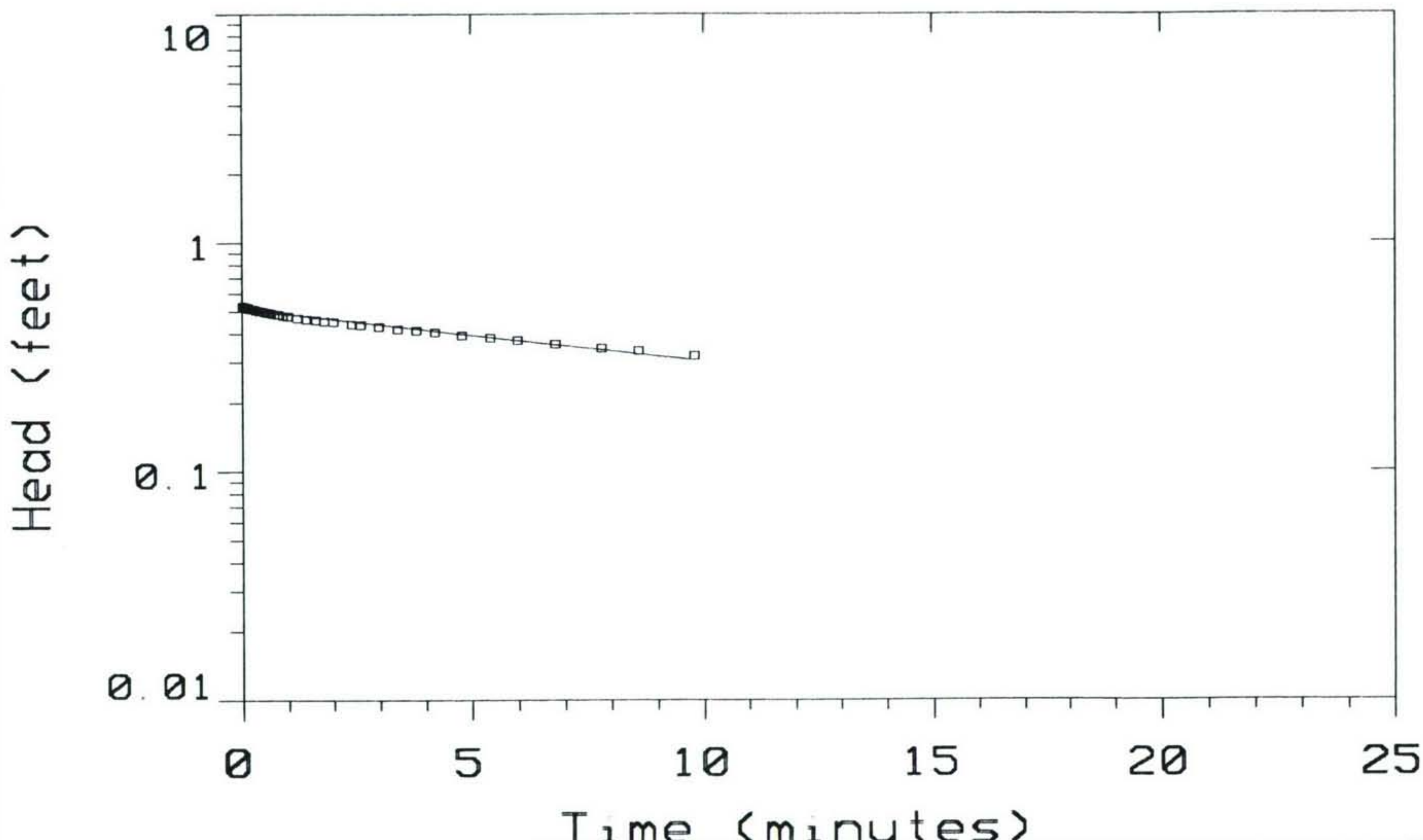
Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.542	0.3250	0.507
0.0083	0.533	0.3333	0.504
0.0166	0.530	0.3500	0.504
0.0250	0.530	0.3666	0.504
0.0333	0.526	0.3833	0.501
0.0416	0.526	0.4000	0.501
0.0500	0.523	0.4166	0.501
0.0583	0.523	0.4333	0.501
0.0666	0.523	0.4500	0.498
0.0750	0.523	0.4666	0.498
0.0833	0.520	0.4833	0.498
0.0916	0.520	0.5000	0.498
0.1000	0.520	0.5166	0.495
0.1083	0.520	0.5333	0.495
0.1166	0.520	0.5500	0.495
0.1250	0.517	0.5666	0.495
0.1333	0.517	0.5833	0.495
0.1416	0.517	0.6000	0.491
0.1500	0.517	0.6166	0.491
0.1583	0.514	0.6333	0.491
0.1666	0.514	0.6500	0.488
0.1750	0.514	0.6666	0.488
0.1833	0.514	0.6833	0.488
0.1916	0.514	0.7000	0.488
0.2000	0.514	0.7166	0.488
0.2083	0.514	0.7333	0.485
0.2166	0.510	0.7500	0.485
0.2250	0.510	0.7666	0.485
0.2333	0.510	0.7833	0.485
0.2416	0.510	0.8000	0.482
0.2500	0.510	0.8166	0.482
0.2583	0.510	0.8333	0.482
0.2666	0.510	0.8500	0.482
0.2750	0.507	0.8666	0.482
0.2833	0.507	0.8833	0.479
0.2916	0.507	0.9000	0.479
0.3000	0.507	0.9166	0.479
0.3083	0.507	0.9333	0.479
0.3166	0.504	0.9500	0.479

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:10	Date	09/21 /93
Logger Test	4	INPUT 1 Level (F)	

Step 0 09/21 14:36:52

Elapsed Time	INPUT 1
0.9666	0.479
0.9833	0.479
1.0000	0.476
1.2000	0.469
1.4000	0.463
1.6000	0.460
1.8000	0.453
2.0000	0.450
2.2000	0.444
2.4000	0.441
2.6000	0.437
2.8000	0.431
3.0000	0.428
3.2000	0.425
3.4000	0.418
3.6000	0.415
3.8000	0.412
4.0000	0.409
4.2000	0.406
4.4000	0.399
4.6000	0.396
4.8000	0.393
5.0000	0.390
5.2000	0.387
5.4000	0.384
5.6000	0.380
5.8000	0.377
6.0000	0.374
6.2000	0.371
6.4000	0.368
6.6000	0.364
6.8000	0.361
7.0000	0.358
7.2000	0.355
7.4000	0.352
7.6000	0.349
7.8000	0.345
8.0000	0.345
8.2000	0.342
8.4000	0.339
8.6000	0.336
8.8000	0.333
9.0000	0.330
9.2000	0.326
9.4000	0.326
9.6000	0.323
9.8000	0.320



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 0001571 ft/min	by Ecology & Environment	Well: E3-P36-M01
TRANSMISSIVITY 0003912 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 5300 ft	AQUIFER Endless	SUDBURY
Data Set P36M1S0	THICKNESS 2 490	
Date 9-21-93	SCREEN top 9 000 base 19 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 17 01 TD 19 50	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M02

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:17	Date	09/21 /93
Logger Test	3	INPUT 1 Level (F)	

Step 0 09/21 12:40:06

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-0.701	0.3250	0.136
0.0083	-0.057	0.3333	0.136
0.0166	-0.006	0.3500	0.139
0.0250	0.165	0.3666	0.136
0.0333	0.139	0.3833	0.136
0.0416	0.146	0.4000	0.136
0.0500	0.142	0.4166	0.136
0.0583	0.146	0.4333	0.136
0.0666	0.146	0.4500	0.136
0.0750	0.146	0.4666	0.136
0.0833	0.142	0.4833	0.136
0.0916	0.146	0.5000	0.136
0.1000	0.146	0.5166	0.136
0.1083	0.146	0.5333	0.136
0.1166	0.142	0.5500	0.136
0.1250	0.142	0.5666	0.133
0.1333	0.142	0.5833	0.133
0.1416	0.142	0.6000	0.133
0.1500	0.142	0.6166	0.133
0.1583	0.142	0.6333	0.133
0.1666	0.139	0.6500	0.133
0.1750	0.142	0.6666	0.133
0.1833	0.139	0.6833	0.133
0.1916	0.142	0.7000	0.133
0.2000	0.139	0.7166	0.133
0.2083	0.142	0.7333	0.133
0.2166	0.139	0.7500	0.133
0.2250	0.139	0.7666	0.133
0.2333	0.139	0.7833	0.133
0.2416	0.139	0.8000	0.130
0.2500	0.139	0.8166	0.130
0.2583	0.139	0.8333	0.130
0.2666	0.139	0.8500	0.133
0.2750	0.139	0.8666	0.130
0.2833	0.139	0.8833	0.130
0.2916	0.139	0.9000	0.130
0.3000	0.136	0.9166	0.130
0.3083	0.136	0.9333	0.130
0.3166	0.136	0.9500	0.130

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M02

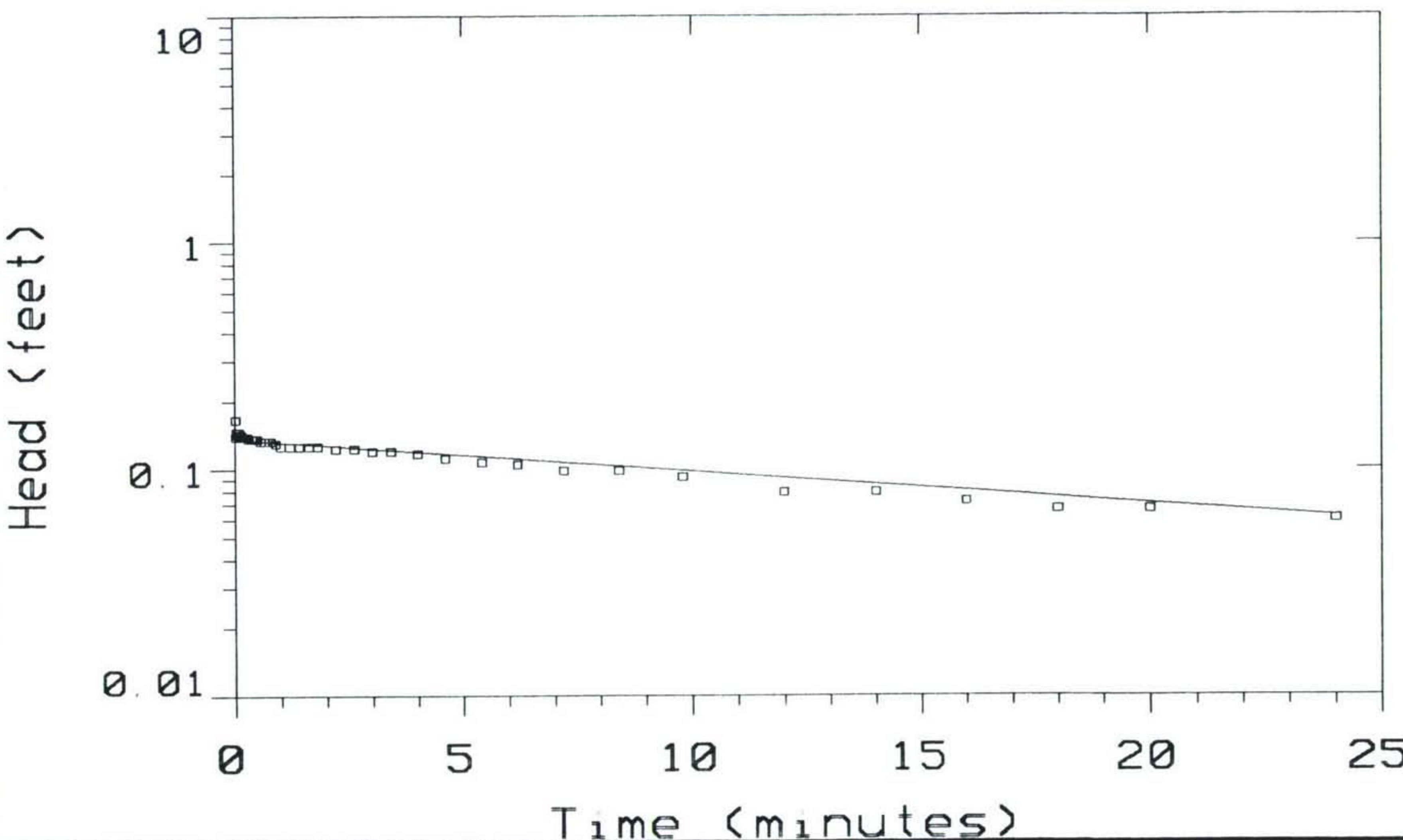
Reference	0.000
SG	1.000
Linearity	0.004
Time	20:17
Logger Test	3

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/21 /93
INPUT 1	Level (F)

Step 0 09/21 12:40:06

Elapsed Time	INPUT 1
0.9666	0.130
0.9833	0.130
1.0000	0.126
1.2000	0.126
1.4000	0.126
1.6000	0.126
1.8000	0.126
2.0000	0.123
2.2000	0.123
2.4000	0.120
2.6000	0.123
2.8000	0.120
3.0000	0.120
3.2000	0.120
3.4000	0.120
3.6000	0.117
3.8000	0.117
4.0000	0.117
4.2000	0.114
4.4000	0.114
4.6000	0.111
4.8000	0.111
5.0000	0.107
5.2000	0.107
5.4000	0.107
5.6000	0.107
5.8000	0.107
6.0000	0.104
6.2000	0.104
6.4000	0.101
6.6000	0.101
6.8000	0.101
7.0000	0.098
7.2000	0.098
7.4000	0.098
7.6000	0.098
7.8000	0.098
8.0000	0.098
8.2000	0.098

Elapsed Time	INPUT 1
8.4000	0.098
8.6000	0.095
8.8000	0.095
9.0000	0.095
9.2000	0.095
9.4000	0.095
9.6000	0.095
9.8000	0.092
10.0000	0.092
12.0000	0.079
14.0000	0.079
16.0000	0.072
18.0000	0.066
20.0000	0.066
22.0000	0.063
24.0000	0.060
26.0000	0.057
28.0000	0.050
30.0000	0.047
32.0000	0.047
34.0000	0.044
36.0000	0.041
38.0000	0.041
40.0000	0.041
42.0000	0.034
44.0000	0.034
46.0000	0.031
48.0000	0.031
50.0000	0.028
52.0000	0.025
54.0000	0.025
56.0000	0.025
58.0000	0.025
60.0000	0.022



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 0001274 ft/min

TRANSMISSIVITY 0006624 sq ft/min

INITIAL HEAD 1650 ft

Data Set P36M2S0 | Date 9-21-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 5 200

SCREEN top 10 00 base 20 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 15 60 TD 20 80

Well Slug Test Data

Well: E3-P36-M02

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M03

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	20:24	Date	09/21 /93
Logger Test	3	INPUT 2 Level (F)	

Step 0 09/21 12:40:06

Elapsed Time	INPUT 2	Elapsed Time	INPUT 2
0.0000	0.003	0.3250	0.359
0.0083	1.614	0.3333	0.356
0.0166	1.261	0.3500	0.356
0.0250	1.378	0.3666	0.353
0.0333	1.018	0.3833	0.350
0.0416	0.782	0.4000	0.350
0.0500	0.665	0.4166	0.350
0.0583	0.564	0.4333	0.346
0.0666	0.384	0.4500	0.343
0.0750	0.346	0.4666	0.343
0.0833	0.419	0.4833	0.340
0.0916	0.305	0.5000	0.340
0.1000	0.397	0.5166	0.337
0.1083	0.378	0.5333	0.337
0.1166	0.381	0.5500	0.334
0.1250	0.384	0.5666	0.334
0.1333	0.381	0.5833	0.331
0.1416	0.381	0.6000	0.331
0.1500	0.378	0.6166	0.328
0.1583	0.378	0.6333	0.328
0.1666	0.378	0.6500	0.324
0.1750	0.375	0.6666	0.324
0.1833	0.375	0.6833	0.321
0.1916	0.375	0.7000	0.321
0.2000	0.372	0.7166	0.318
0.2083	0.372	0.7333	0.318
0.2166	0.372	0.7500	0.318
0.2250	0.369	0.7666	0.318
0.2333	0.369	0.7833	0.315
0.2416	0.369	0.8000	0.315
0.2500	0.365	0.8166	0.312
0.2583	0.365	0.8333	0.312
0.2666	0.365	0.8500	0.312
0.2750	0.365	0.8666	0.309
0.2833	0.362	0.8833	0.309
0.2916	0.362	0.9000	0.309
0.3000	0.362	0.9166	0.309
0.3083	0.359	0.9333	0.305
0.3166	0.359	0.9500	0.305

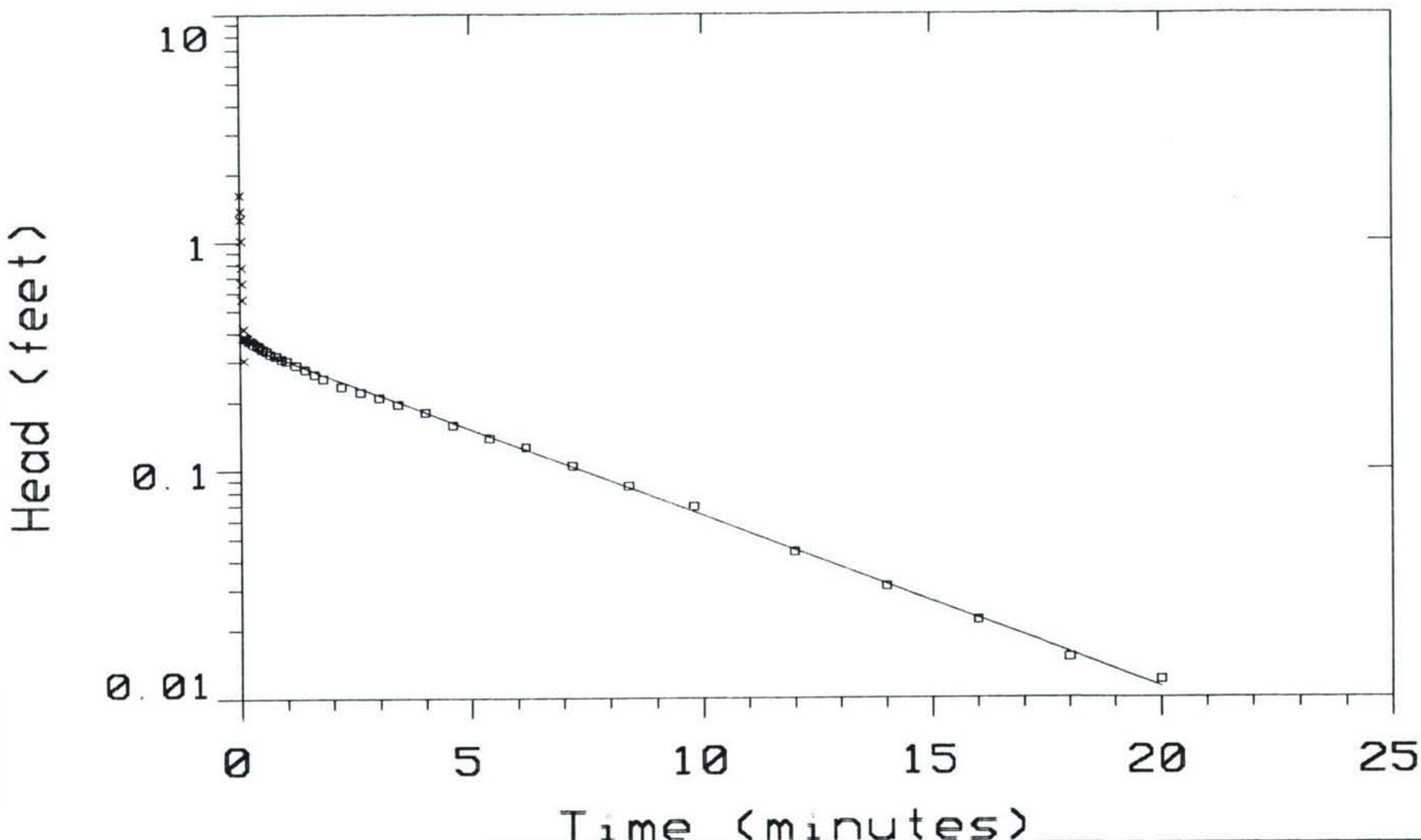
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M03

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	20:24	Date	09/21 /93
Logger Test	3	INPUT 2 Level (F)	

Step 0 09/21 12:40:06

Elapsed Time	INPUT 2
0.9666	0.305
0.9833	0.302
1.0000	0.302
1.2000	0.290
1.4000	0.277
1.6000	0.264
1.8000	0.252
2.0000	0.242
2.2000	0.233
2.4000	0.227
2.6000	0.220
2.8000	0.214
3.0000	0.208
3.2000	0.205
3.4000	0.195
3.6000	0.189
3.8000	0.186
4.0000	0.179
4.2000	0.170
4.4000	0.164
4.6000	0.157
4.8000	0.154
5.0000	0.151
5.2000	0.145
5.4000	0.138
5.6000	0.138
5.8000	0.135
6.0000	0.129
6.2000	0.126
6.4000	0.119
6.6000	0.116
6.8000	0.113
7.0000	0.107
7.2000	0.104
7.4000	0.100
7.6000	0.097
7.8000	0.091
8.0000	0.091
8.2000	0.088

Elapsed Time	INPUT 2
8.4000	0.085
8.6000	0.085
8.8000	0.082
9.0000	0.078
9.2000	0.075
9.4000	0.072
9.6000	0.072
9.8000	0.069
10.0000	0.066
12.0000	0.044
14.0000	0.031
16.0000	0.022
18.0000	0.015
20.0000	0.012
22.0000	0.006
24.0000	0.003
26.0000	0.003
28.0000	0.003
30.0000	-0.003
32.0000	0.003
34.0000	-0.003
36.0000	0.000
38.0000	0.000
40.0000	-0.003
42.0000	-0.003
44.0000	0.000
46.0000	-0.003
48.0000	-0.003
50.0000	-0.003
52.0000	-0.006
54.0000	-0.006
56.0000	-0.003
58.0000	-0.003
60.0000	-0.003



MODEL TYPE: BOUWER and RICE	
CONDUCTIVITY: .0008077 ft/min	
TRANSMISSIVITY: .003634 sq. ft/min	
INITIAL HEAD: 1.614 ft	
Data Set: P36M3S0	Date: 9-1-93

for: +USAEC
by: Ecology & Environment

WELL DATA: Units: ft
AQUIFER: Endless
THICKNESS: 4.500
SCREEN: top: 10.00 base: 20.00
DIAMETER: casing: .3400 intake: .3400
DEPTH: Water Table: 16.68 TD: 21.18

Well Slug Test Data

Well: E3-P36-M03

SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M01

Reference	0.000	Scale Factor	10.012
SG	1.000	Offset	-0.042
Linearity	0.009	Delay mSEC	50.000
Time	20:29	Date	09/21 /93
Logger Test	3	INPUT 3 Level (F)	

Step 0 09/21 12:40:06

Elapsed Time	INPUT 3
0.0000	-0.025
0.0083	-0.018
0.0166	-0.787
0.0250	-1.720
0.0333	-1.872
0.0416	-1.730
0.0500	-1.587
0.0583	-1.382
0.0666	-2.422
0.0750	-0.866
0.0833	-1.489
0.0916	-2.195
0.1000	-1.923
0.1083	0.385
0.1166	-1.391
0.1250	-0.597
0.1333	-0.872
0.1416	-0.733
0.1500	-0.797
0.1583	-0.781
0.1666	-0.778
0.1750	-0.778
0.1833	-0.774
0.1916	-0.771
0.2000	-0.768
0.2083	-0.768
0.2166	-0.765
0.2250	-0.762
0.2333	-0.762
0.2416	-0.759
0.2500	-0.755
0.2583	-0.755
0.2666	-0.752
0.2750	-0.749
0.2833	-0.749
0.2916	-0.749
0.3000	-0.746
0.3083	-0.743
0.3166	-0.743

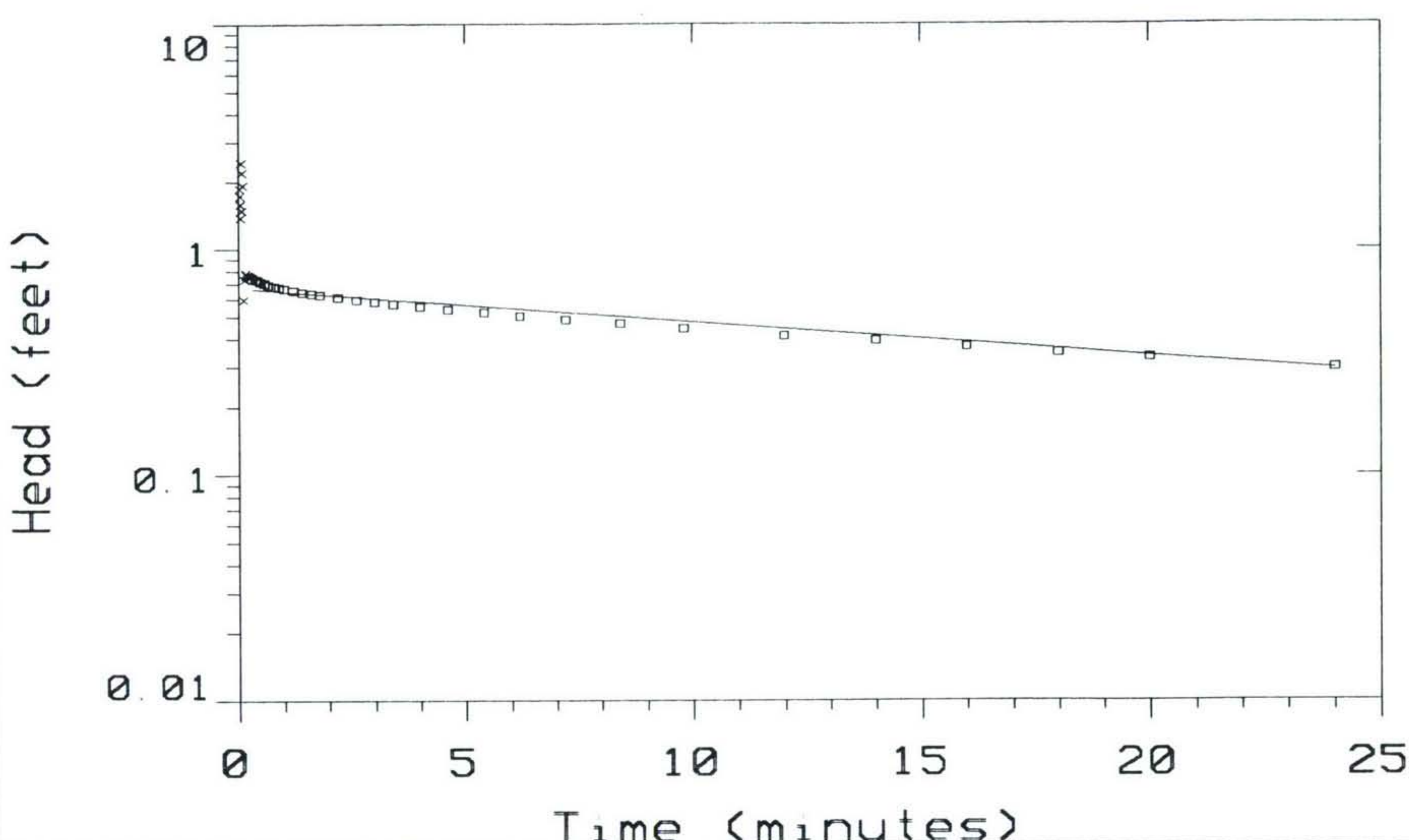
Elapsed Time	INPUT 3
0.3250	-0.740
0.3333	-0.740
0.3500	-0.736
0.3666	-0.733
0.3833	-0.730
0.4000	-0.727
0.4166	-0.727
0.4333	-0.724
0.4500	-0.721
0.4666	-0.717
0.4833	-0.717
0.5000	-0.714
0.5166	-0.711
0.5333	-0.708
0.5500	-0.708
0.5666	-0.705
0.5833	-0.702
0.6000	-0.702
0.6166	-0.698
0.6333	-0.695
0.6500	-0.695
0.6666	-0.692
0.6833	-0.692
0.7000	-0.689
0.7166	-0.689
0.7333	-0.689
0.7500	-0.686
0.7666	-0.686
0.7833	-0.683
0.8000	-0.679
0.8166	-0.679
0.8333	-0.679
0.8500	-0.676
0.8666	-0.676
0.8833	-0.676
0.9000	-0.673
0.9166	-0.673
0.9333	-0.670
0.9500	-0.670

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M01

Reference	0.000	Scale Factor	10.012
SG	1.000	Offset	-0.042
Linearity	0.009	Delay mSEC	50.000
Time	20:29	Date	09/21 /93
Logger Test	3	INPUT 3 Level (F)	

Step 0 09/21 12:40:06

Elapsed Time	INPUT 3	Elapsed Time	INPUT 3
0.9666	-0.670	8.4000	-0.468
0.9833	-0.667	8.6000	-0.464
1.0000	-0.667	8.8000	-0.461
1.2000	-0.654	9.0000	-0.458
1.4000	-0.645	9.2000	-0.455
1.6000	-0.635	9.4000	-0.452
1.8000	-0.626	9.6000	-0.449
2.0000	-0.619	9.8000	-0.445
2.2000	-0.610	10.0000	-0.442
2.4000	-0.604	12.0000	-0.414
2.6000	-0.597	14.0000	-0.392
2.8000	-0.591	16.0000	-0.370
3.0000	-0.585	18.0000	-0.347
3.2000	-0.578	20.0000	-0.332
3.4000	-0.572	22.0000	-0.313
3.6000	-0.566	24.0000	-0.297
3.8000	-0.562	26.0000	-0.281
4.0000	-0.556	28.0000	-0.265
4.2000	-0.550	30.0000	-0.253
4.4000	-0.547	32.0000	-0.240
4.6000	-0.540	34.0000	-0.227
4.8000	-0.537	36.0000	-0.218
5.0000	-0.531	38.0000	-0.205
5.2000	-0.528	40.0000	-0.196
5.4000	-0.525	42.0000	-0.186
5.6000	-0.521	44.0000	-0.177
5.8000	-0.515	46.0000	-0.167
6.0000	-0.512	48.0000	-0.158
6.2000	-0.506	50.0000	-0.151
6.4000	-0.502	52.0000	-0.142
6.6000	-0.499	54.0000	-0.139
6.8000	-0.496	56.0000	-0.129
7.0000	-0.490	58.0000	-0.123
7.2000	-0.487	60.0000	-0.117
7.4000	-0.483		
7.6000	-0.480		
7.8000	-0.474		
8.0000	-0.474		
8.2000	-0.471		



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 0002519 ft/min	by Ecology & Environment	Well: E3-P37-M01
TRANSMISSIVITY 001811 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 1 872 ft	AQUIFER Endless	SUDBURY
Data Set P37M1S0	THICKNESS 7 190	
Date 9-21-93	SCREEN top 11 00 base 21 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 13 95 TD 21 14	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M02

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	21:08	Date	09/21 /93
Logger Test	2	INPUT 1 Level (F)	

Step 0 09/21 11:24:27

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	0.000	0.3250	0.336
0.0083	0.000	0.3333	0.336
0.0166	-0.107	0.3500	0.330
0.0250	0.238	0.3666	0.326
0.0333	0.330	0.3833	0.323
0.0416	0.425	0.4000	0.320
0.0500	0.418	0.4166	0.314
0.0583	0.418	0.4333	0.311
0.0666	0.415	0.4500	0.307
0.0750	0.409	0.4666	0.304
0.0833	0.406	0.4833	0.301
0.0916	0.403	0.5000	0.295
0.1000	0.399	0.5166	0.295
0.1083	0.396	0.5333	0.288
0.1166	0.393	0.5500	0.285
0.1250	0.393	0.5666	0.282
0.1333	0.387	0.5833	0.279
0.1416	0.387	0.6000	0.276
0.1500	0.384	0.6166	0.272
0.1583	0.380	0.6333	0.269
0.1666	0.377	0.6500	0.266
0.1750	0.377	0.6666	0.263
0.1833	0.374	0.6833	0.260
0.1916	0.371	0.7000	0.257
0.2000	0.368	0.7166	0.253
0.2083	0.368	0.7333	0.250
0.2166	0.364	0.7500	0.250
0.2250	0.361	0.7666	0.247
0.2333	0.361	0.7833	0.244
0.2416	0.358	0.8000	0.241
0.2500	0.355	0.8166	0.238
0.2583	0.352	0.8333	0.234
0.2666	0.349	0.8500	0.231
0.2750	0.349	0.8666	0.231
0.2833	0.349	0.8833	0.228
0.2916	0.345	0.9000	0.225
0.3000	0.342	0.9166	0.222
0.3083	0.342	0.9333	0.218
0.3166	0.339	0.9500	0.218

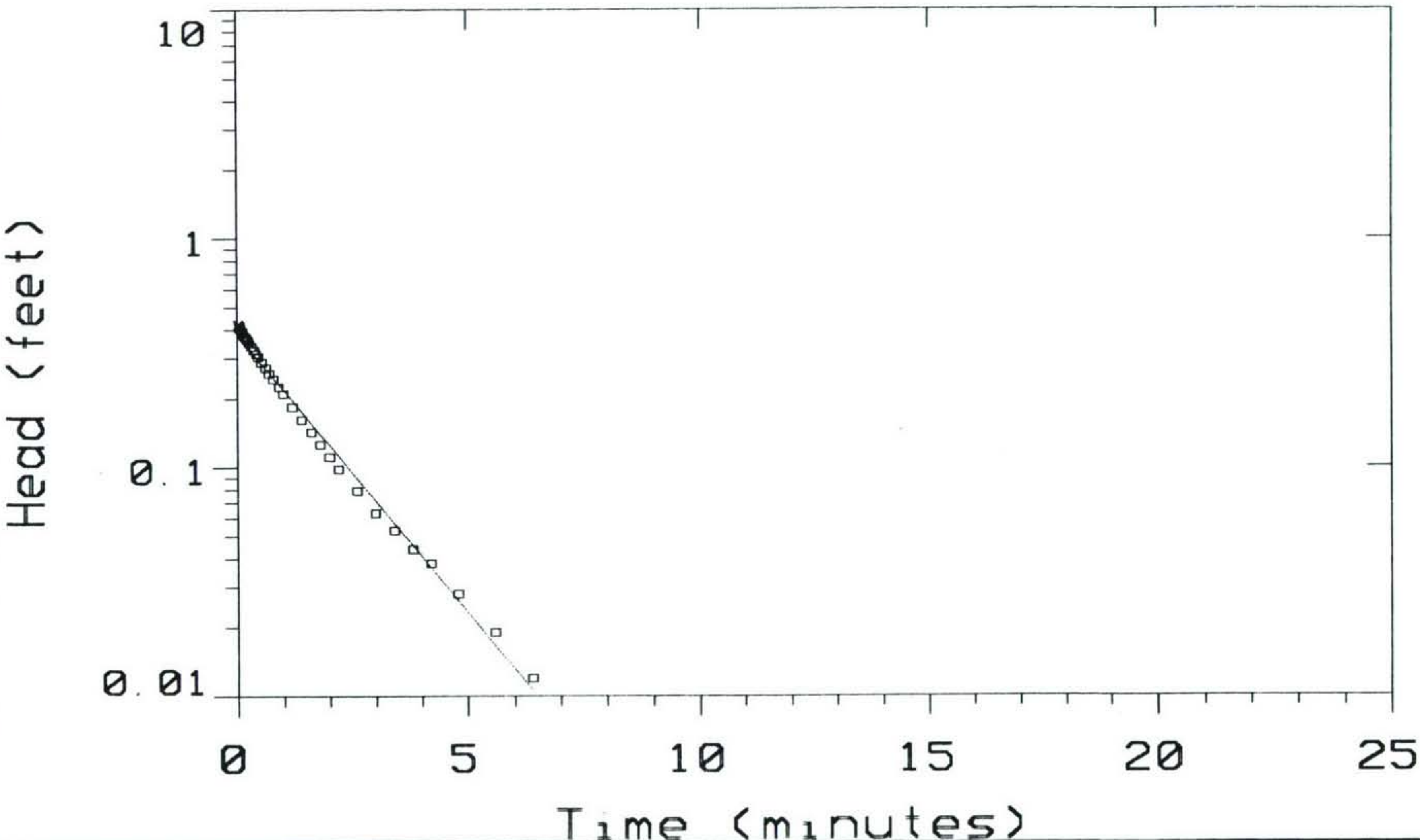
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M02

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	21:08	Date	09/21 /93
Logger Test	2	INPUT 1 Level (F)	

Step 0 09/21 11:24:27

Elapsed Time	INPUT 1
0.9666	0.215
0.9833	0.212
1.0000	0.209
1.2000	0.184
1.4000	0.161
1.6000	0.142
1.8000	0.126
2.0000	0.111
2.2000	0.098
2.4000	0.088
2.6000	0.079
2.8000	0.069
3.0000	0.063
3.2000	0.057
3.4000	0.053
3.6000	0.047
3.8000	0.044
4.0000	0.038
4.2000	0.038
4.4000	0.034
4.6000	0.031
4.8000	0.028
5.0000	0.025
5.2000	0.022
5.4000	0.022
5.6000	0.019
5.8000	0.015
6.0000	0.015
6.2000	0.012
6.4000	0.012
6.6000	0.009
6.8000	0.009
7.0000	0.009
7.2000	0.009
7.4000	0.006
7.6000	0.006
7.8000	0.006
8.0000	0.006
8.2000	0.006

Elapsed Time	INPUT 1
8.4000	0.006
8.6000	0.003
8.8000	0.003
9.0000	0.003
9.2000	0.003
9.4000	0.003
9.6000	0.003
9.8000	0.003
10.0000	0.003
12.0000	0.003
14.0000	0.000
16.0000	0.000
18.0000	0.000



MODEL TYPE: BOUWER and RICE CONDUCTIVITY: .001938 ft/min TRANSMISSIVITY: .008779 sq ft/min INITIAL HEAD: .4250 ft Data Set: P37M2S0 Date: 9-21-93	for: USAEC by: Ecology & Environment WELL DATA Units: ft AQUIFER: Endless THICKNESS: 4.530 SCREEN top: 10.00 base: 20.00 DIAMETER casing: .3400 intake: .3400 DEPTH Water Table: 16.32 TD: 20.85	Well Slug Test Data Well: E3-P37-M02 SUDBURY, MA SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M03

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	21:13	Date	09/21 /93
Logger Test	2	INPUT 2 Level (F)	

Step 0 09/21 11:24:27

Elapsed Time	INPUT 2	Elapsed Time	INPUT 2
0.0000	0.009	0.3250	0.179
0.0083	0.009	0.3333	0.176
0.0166	0.009	0.3500	0.173
0.0250	0.009	0.3666	0.167
0.0333	0.018	0.3833	0.160
0.0416	0.015	0.4000	0.157
0.0500	0.006	0.4166	0.154
0.0583	0.012	0.4333	0.148
0.0666	0.006	0.4500	0.145
0.0750	0.668	0.4666	0.141
0.0833	0.914	0.4833	0.138
0.0916	0.334	0.5000	0.135
0.1000	0.264	0.5166	0.132
0.1083	0.460	0.5333	0.126
0.1166	0.413	0.5500	0.123
0.1250	0.447	0.5666	0.119
0.1333	0.621	0.5833	0.116
0.1416	0.365	0.6000	0.113
0.1500	0.239	0.6166	0.110
0.1583	0.287	0.6333	0.107
0.1666	0.271	0.6500	0.104
0.1750	0.261	0.6666	0.100
0.1833	0.252	0.6833	0.097
0.1916	0.242	0.7000	0.097
0.2000	0.236	0.7166	0.094
0.2083	0.230	0.7333	0.091
0.2166	0.223	0.7500	0.088
0.2250	0.220	0.7666	0.088
0.2333	0.214	0.7833	0.085
0.2416	0.211	0.8000	0.082
0.2500	0.208	0.8166	0.082
0.2583	0.205	0.8333	0.078
0.2666	0.201	0.8500	0.075
0.2750	0.198	0.8666	0.075
0.2833	0.195	0.8833	0.072
0.2916	0.192	0.9000	0.072
0.3000	0.189	0.9166	0.069
0.3083	0.186	0.9333	0.069
0.3166	0.182	0.9500	0.066

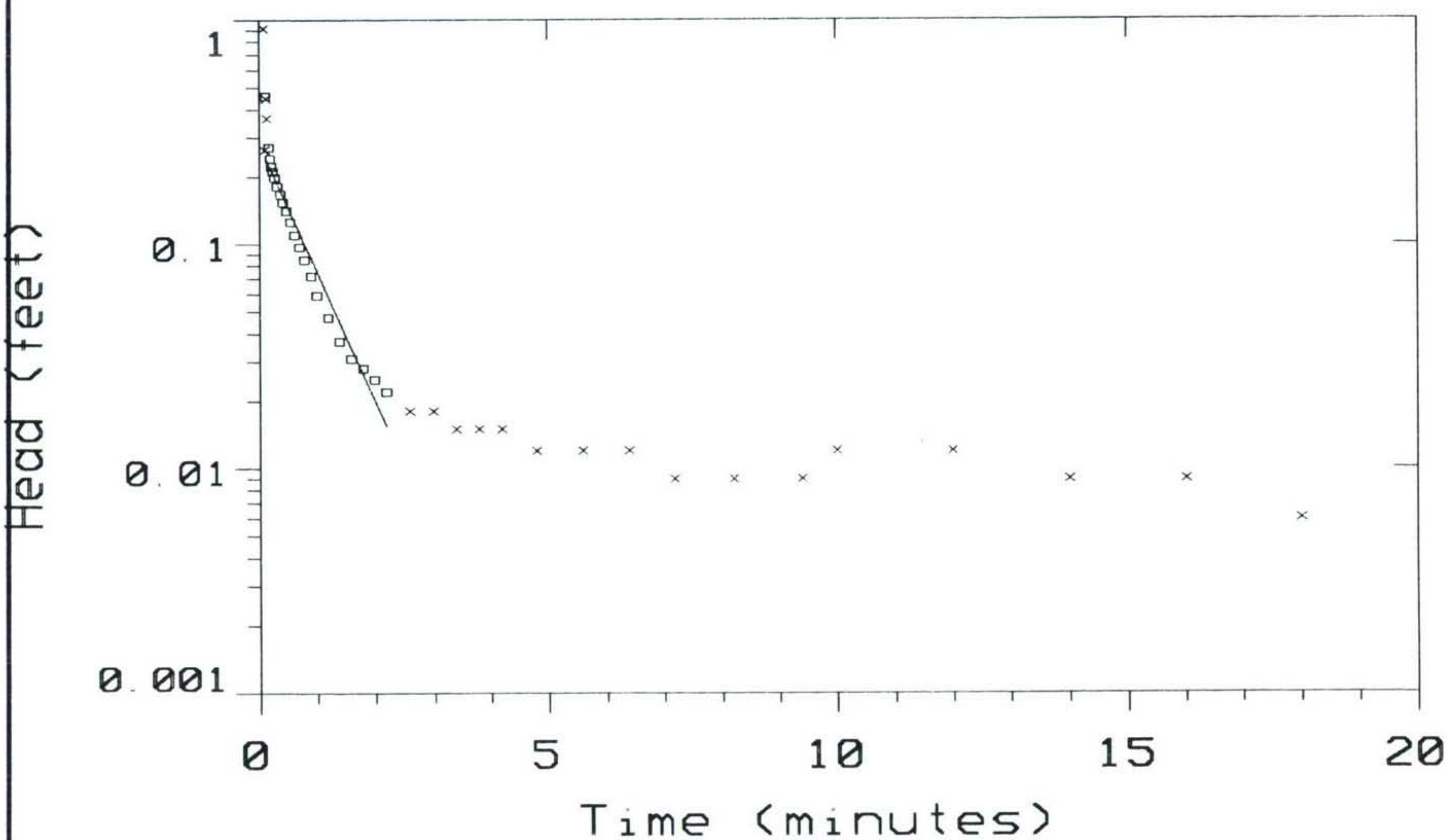
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M03

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	21:13	Date	09/21 /93
Logger Test	2	INPUT 2 Level (F)	

Step 0 09/21 11:24:27

Elapsed Time	INPUT 2
0.9666	0.063
0.9833	0.063
1.0000	0.059
1.2000	0.047
1.4000	0.037
1.6000	0.031
1.8000	0.028
2.0000	0.025
2.2000	0.022
2.4000	0.022
2.6000	0.018
2.8000	0.018
3.0000	0.018
3.2000	0.015
3.4000	0.015
3.6000	0.015
3.8000	0.015
4.0000	0.015
4.2000	0.015
4.4000	0.015
4.6000	0.015
4.8000	0.012
5.0000	0.012
5.2000	0.012
5.4000	0.012
5.6000	0.012
5.8000	0.012
6.0000	0.012
6.2000	0.012
6.4000	0.012
6.6000	0.009
6.8000	0.009
7.0000	0.012
7.2000	0.009
7.4000	0.009
7.6000	0.009
7.8000	0.009
8.0000	0.009
8.2000	0.009

Elapsed Time	INPUT 2
8.4000	0.009
8.6000	0.009
8.8000	0.009
9.0000	0.009
9.2000	0.009
9.4000	0.009
9.6000	0.009
9.8000	0.009
10.0000	0.012
12.0000	0.012
14.0000	0.009
16.0000	0.009
18.0000	0.006



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 005847 ft/min

TRANSMISSIVITY 02859 sq ft/min

INITIAL HEAD 9140 ft

Data Set P37M3S0

Date 9-21-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 4 890

SCREEN top 10 00 base 20 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 16 93 TD 21 82

Well Slug Test Data

Well: E3-P37-M03

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P57-M01

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	19:15		Date	09/23 /93
Logger Test	5		INPUT 1 Level (F)	

Step 0 09/23 14:42:54

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	3.577	0.3250	1.111
0.0083	3.704	0.3333	1.111
0.0166	2.850	0.3500	1.104
0.0250	0.396	0.3666	1.101
0.0333	1.561	0.3833	1.098
0.0416	1.393	0.4000	1.095
0.0500	1.276	0.4166	1.088
0.0583	1.244	0.4333	1.085
0.0666	1.238	0.4500	1.082
0.0750	1.212	0.4666	1.079
0.0833	1.199	0.4833	1.076
0.0916	1.187	0.5000	1.072
0.1000	1.180	0.5166	1.069
0.1083	1.174	0.5333	1.066
0.1166	1.171	0.5500	1.063
0.1250	1.164	0.5666	1.063
0.1333	1.164	0.5833	1.060
0.1416	1.161	0.6000	1.057
0.1500	1.158	0.6166	1.053
0.1583	1.155	0.6333	1.053
0.1666	1.152	0.6500	1.050
0.1750	1.152	0.6666	1.047
0.1833	1.149	0.6833	1.047
0.1916	1.145	0.7000	1.047
0.2000	1.145	0.7166	1.044
0.2083	1.145	0.7333	1.044
0.2166	1.139	0.7500	1.041
0.2250	1.136	0.7666	1.041
0.2333	1.136	0.7833	1.038
0.2416	1.133	0.8000	1.038
0.2500	1.130	0.8166	1.031
0.2583	1.126	0.8333	1.034
0.2666	1.130	0.8500	1.031
0.2750	1.123	0.8666	1.031
0.2833	1.120	0.8833	1.028
0.2916	1.120	0.9000	1.028
0.3000	1.117	0.9166	1.025
0.3083	1.114	0.9333	1.025
0.3166	1.114	0.9500	1.022

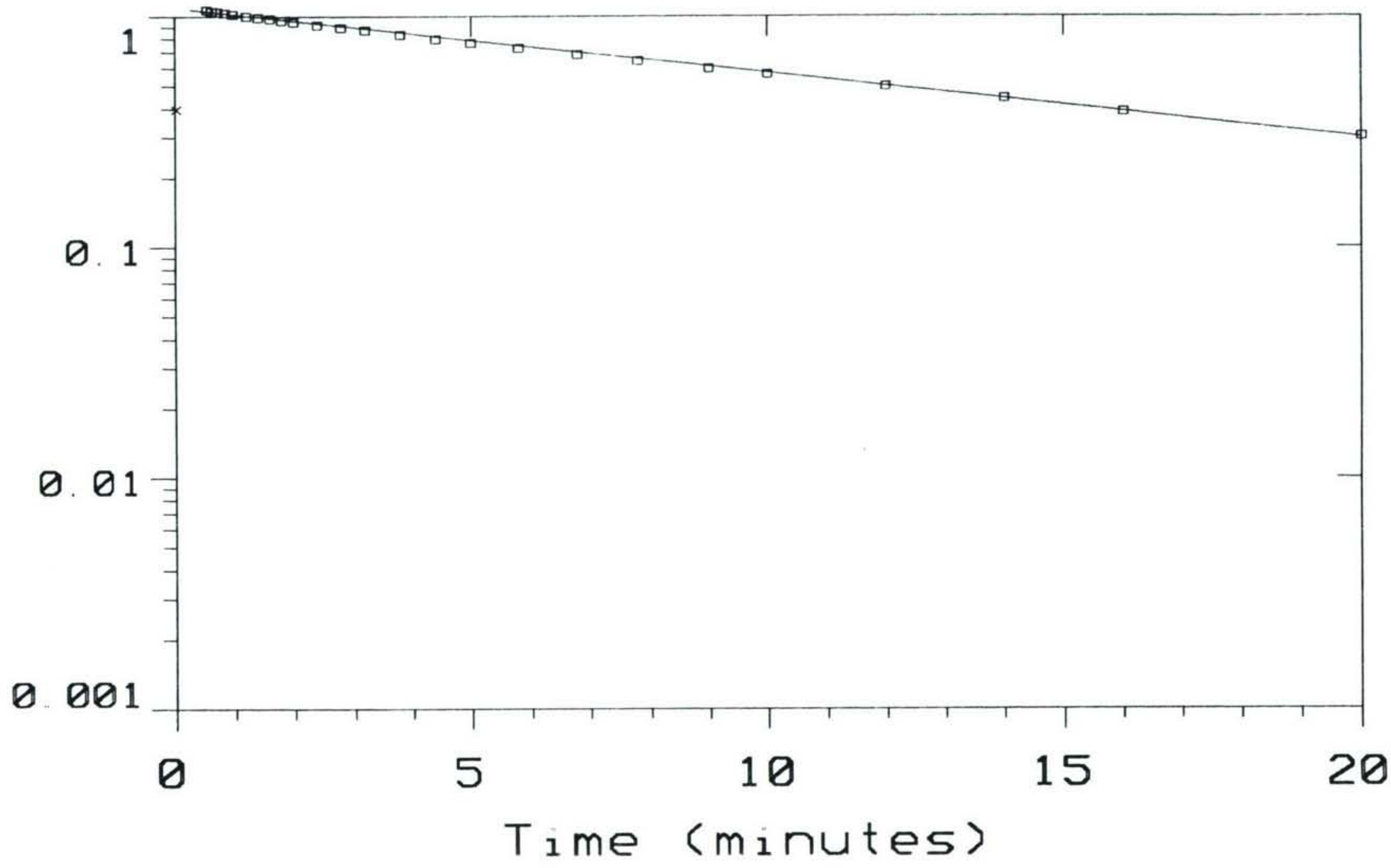
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P57-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:15	Date	09/23 /93
Logger Test	5	INPUT 1 Level (F)	

Step 0 09/23 14:42:54

Elapsed Time	INPUT 1
0.9666	1.022
0.9833	1.022
1.0000	1.018
1.2000	1.003
1.4000	0.990
1.6000	0.974
1.8000	0.958
2.0000	0.945
2.2000	0.930
2.4000	0.917
2.6000	0.904
2.8000	0.891
3.0000	0.879
3.2000	0.869
3.4000	0.857
3.6000	0.844
3.8000	0.834
4.0000	0.822
4.2000	0.809
4.4000	0.799
4.6000	0.790
4.8000	0.777
5.0000	0.768
5.2000	0.755
5.4000	0.749
5.6000	0.736
5.8000	0.730
6.0000	0.720
6.2000	0.711
6.4000	0.701
6.6000	0.692
6.8000	0.685
7.0000	0.676
7.2000	0.669
7.4000	0.660
7.6000	0.650
7.8000	0.644
8.0000	0.634
8.2000	0.628

Elapsed Time	INPUT 1
8.4000	0.618
8.6000	0.612
8.8000	0.603
9.0000	0.596
9.2000	0.590
9.4000	0.584
9.6000	0.577
9.8000	0.568
10.0000	0.561
12.0000	0.498
14.0000	0.441
16.0000	0.387
18.0000	0.339
20.0000	0.301
22.0000	0.263
24.0000	0.231
26.0000	0.203
28.0000	0.177
30.0000	0.158
32.0000	0.139
34.0000	0.123
36.0000	0.107
38.0000	0.095
40.0000	0.082
42.0000	0.073
44.0000	0.066
46.0000	0.057
48.0000	0.050
50.0000	0.044
52.0000	0.038
54.0000	0.034



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 0003494 ft/min	by Ecology & Environment	Well: E3-P57-M01
TRANSMISSIVITY 002963 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 3 704 ft	AQUIFER Endless	SUDBURY
Data Set F57MIS0	THICKNESS 8 480	
Date 9-23-93	SCREEN top 10 00 base 20 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 12 34 TD 20 82	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M01

Reference	0.000
SG	1.000
Linearity	0.004
Time	21:19
Logger Test	1

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/21 /93
INPUT 1 Level	(F)

Step 0 09/21 08:59:16

Elapsed Time	INPUT 1
0.0000	0.012
0.0083	1.079
0.0166	1.739
0.0250	1.965
0.0333	1.974
0.0416	1.882
0.0500	1.831
0.0583	1.768
0.0666	1.720
0.0750	1.676
0.0833	1.377
0.0916	0.479
0.1000	0.965
0.1083	0.876
0.1166	0.857
0.1250	0.831
0.1333	0.806
0.1416	0.780
0.1500	0.758
0.1583	0.736
0.1666	0.714
0.1750	0.695
0.1833	0.672
0.1916	0.657
0.2000	0.638
0.2083	0.619
0.2166	0.603
0.2250	0.587
0.2333	0.571
0.2416	0.555
0.2500	0.539
0.2583	0.526
0.2666	0.511
0.2750	0.498
0.2833	0.485
0.2916	0.472
0.3000	0.463
0.3083	0.450
0.3166	0.438

Elapsed Time	INPUT 1
0.3250	0.428
0.3333	0.419
0.3500	0.396
0.3666	0.380
0.3833	0.361
0.4000	0.346
0.4166	0.330
0.4333	0.314
0.4500	0.301
0.4666	0.288
0.4833	0.276
0.5000	0.266
0.5166	0.253
0.5333	0.244
0.5500	0.234
0.5666	0.225
0.5833	0.215
0.6000	0.209
0.6166	0.203
0.6333	0.193
0.6500	0.187
0.6666	0.184
0.6833	0.174
0.7000	0.168
0.7166	0.165
0.7333	0.158
0.7500	0.152
0.7666	0.149
0.7833	0.146
0.8000	0.139
0.8166	0.136
0.8333	0.133
0.8500	0.130
0.8666	0.126
0.8833	0.120
0.9000	0.120
0.9166	0.117
0.9333	0.114
0.9500	0.111

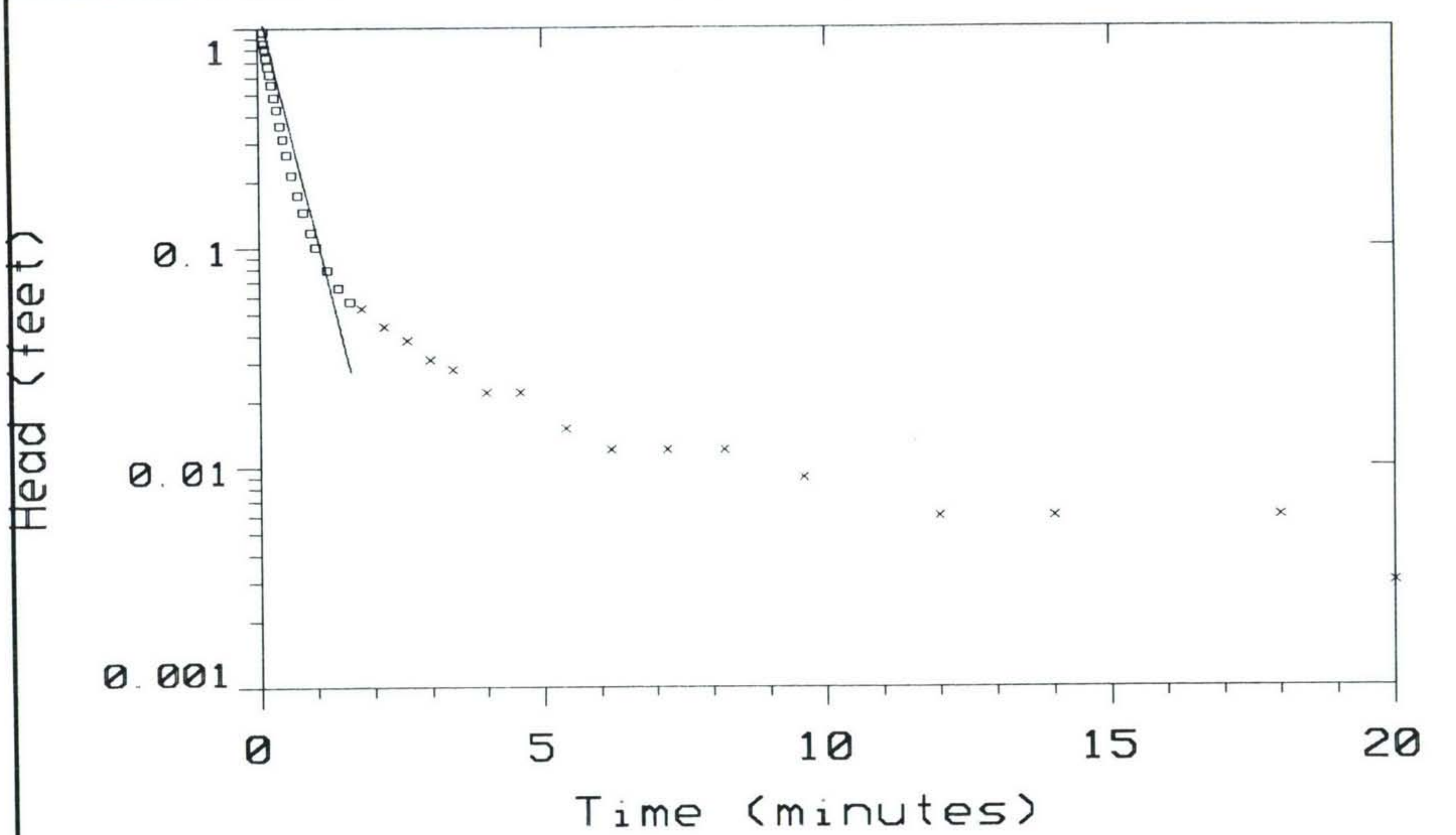
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M01

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	21:19	Date	09/21 /93
Logger Test	1	INPUT 1 Level (F)	

Step 0 09/21 08:59:16

Elapsed Time	INPUT 1
0.9666	0.107
0.9833	0.104
1.0000	0.101
1.2000	0.079
1.4000	0.066
1.6000	0.057
1.8000	0.053
2.0000	0.047
2.2000	0.044
2.4000	0.041
2.6000	0.038
2.8000	0.034
3.0000	0.031
3.2000	0.028
3.4000	0.028
3.6000	0.028
3.8000	0.025
4.0000	0.022
4.2000	0.022
4.4000	0.022
4.6000	0.022
4.8000	0.019
5.0000	0.019
5.2000	0.019
5.4000	0.015
5.6000	0.015
5.8000	0.015
6.0000	0.015
6.2000	0.012
6.4000	0.015
6.6000	0.012
6.8000	0.012
7.0000	0.012
7.2000	0.012
7.4000	0.012
7.6000	0.009
7.8000	0.009
8.0000	0.009
8.2000	0.012

Elapsed Time	INPUT 1
8.4000	0.009
8.6000	0.012
8.8000	0.009
9.0000	0.009
9.2000	0.009
9.4000	0.009
9.6000	0.009
9.8000	0.009
10.0000	0.009
12.0000	0.006
14.0000	0.006
16.0000	0.006
18.0000	0.006
20.0000	0.003
22.0000	0.003
24.0000	0.003
26.0000	0.003
28.0000	0.003
30.0000	0.003
32.0000	0.003
34.0000	0.006
36.0000	0.003
38.0000	0.003
40.0000	0.006
42.0000	0.006
44.0000	0.006
46.0000	0.006
48.0000	0.006



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY .01110 ft/min	by Ecology & Environment	Well: E3-P58-M01
TRANSMISSIVITY .1085 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 1.965 ft	AQUIFER Endless	SUDBURY
Data Set F58MIS0	THICKNESS 9.770	
Date 9-21-93	SCREEN top 9.000 base 19.00	
	DIAMETER casing .3400 intake .3400	
	DEPTH Water Table 9.970 TD 19.74	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M02

Reference	0.000		Scale Factor	9.990
SG	1.000		Offset	-0.009
Linearity	-0.000		Delay mSEC	50.000
Time	21:25		Date	09/21 /93
Logger Test	1		INPUT 2 Level (F)	

Step 0 09/21 08:59:16

Elapsed Time	INPUT 2	Elapsed Time	INPUT 2
0.0000	4.897	0.3250	2.153
0.0083	4.648	0.3333	2.138
0.0166	3.629	0.3500	2.106
0.0250	4.415	0.3666	2.078
0.0333	4.802	0.3833	2.046
0.0416	5.124	0.4000	2.018
0.0500	4.847	0.4166	1.993
0.0583	4.333	0.4333	1.958
0.0666	3.472	0.4500	1.936
0.0750	2.526	0.4666	1.911
0.0833	2.201	0.4833	1.879
0.0916	2.661	0.5000	1.854
0.1000	2.797	0.5166	1.829
0.1083	2.765	0.5333	1.797
0.1166	2.573	0.5500	1.788
0.1250	2.538	0.5666	1.750
0.1333	2.582	0.5833	1.731
0.1416	2.560	0.6000	1.712
0.1500	2.519	0.6166	1.677
0.1583	2.500	0.6333	1.652
0.1666	2.488	0.6500	1.643
0.1750	2.466	0.6666	1.608
0.1833	2.444	0.6833	1.598
0.1916	2.431	0.7000	1.573
0.2000	2.409	0.7166	1.551
0.2083	2.390	0.7333	1.535
0.2166	2.371	0.7500	1.501
0.2250	2.352	0.7666	1.491
0.2333	2.333	0.7833	1.466
0.2416	2.314	0.8000	1.450
0.2500	2.295	0.8166	1.419
0.2583	2.280	0.8333	1.416
0.2666	2.264	0.8500	1.387
0.2750	2.248	0.8666	1.375
0.2833	2.232	0.8833	1.362
0.2916	2.213	0.9000	1.327
0.3000	2.201	0.9166	1.321
0.3083	2.182	0.9333	1.302
0.3166	2.160	0.9500	1.289

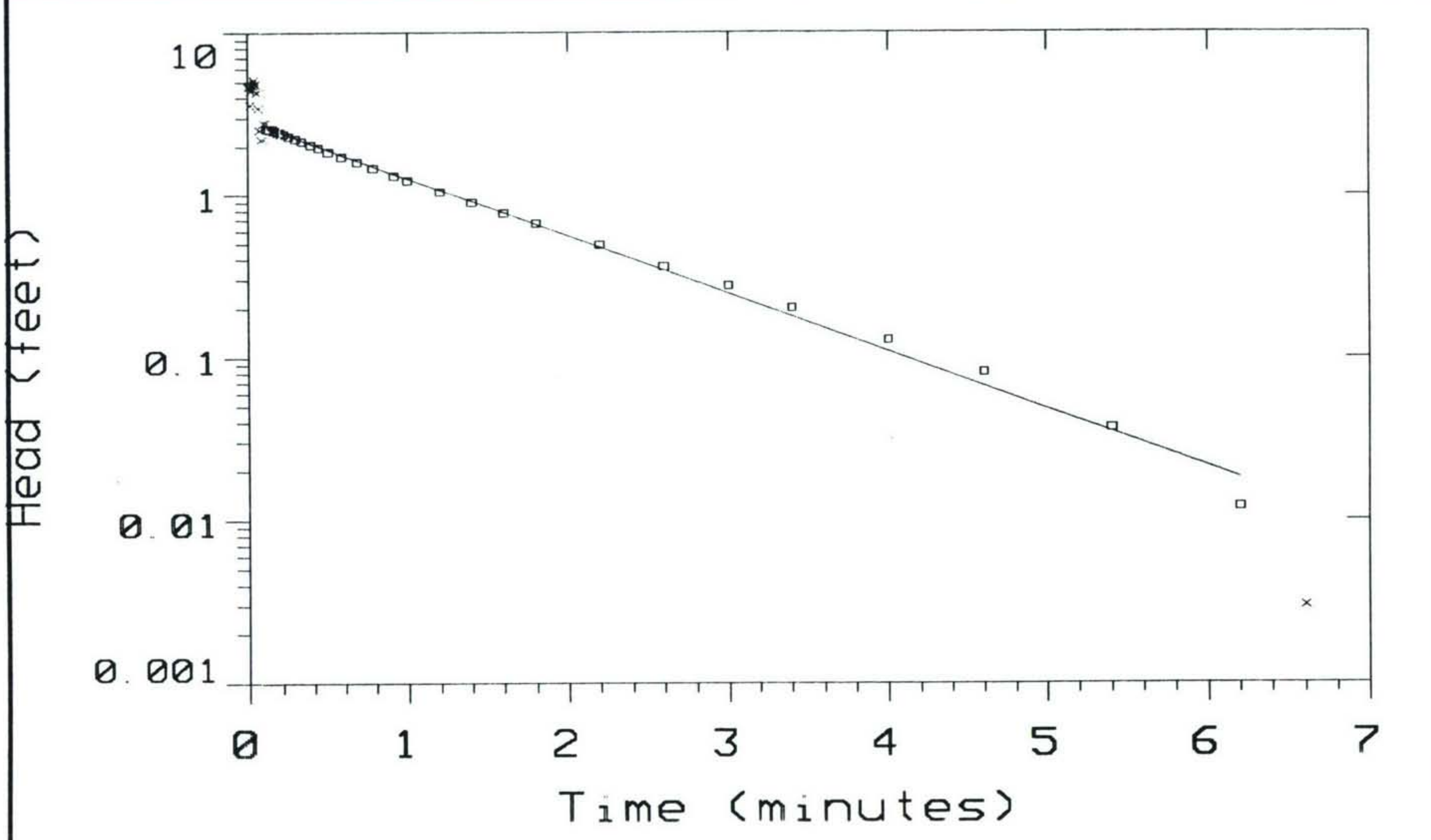
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M02

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	21:25	Date	09/21 /93
Logger Test	1	INPUT 2 Level (F)	

Step 0 09/21 08:59:16

Elapsed Time	INPUT 2
0.9666	1.258
0.9833	1.252
1.0000	1.229
1.2000	1.047
1.4000	0.901
1.6000	0.772
1.8000	0.668
2.0000	0.570
2.2000	0.491
2.4000	0.419
2.6000	0.362
2.8000	0.309
3.0000	0.277
3.2000	0.236
3.4000	0.201
3.6000	0.170
3.8000	0.148
4.0000	0.129
4.2000	0.113
4.4000	0.097
4.6000	0.081
4.8000	0.069
5.0000	0.056
5.2000	0.050
5.4000	0.037
5.6000	0.031
5.8000	0.025
6.0000	0.018
6.2000	0.012
6.4000	0.009
6.6000	0.003
6.8000	0.000
7.0000	0.000
7.2000	-0.006
7.4000	-0.006
7.6000	-0.006
7.8000	-0.006
8.0000	-0.012
8.2000	-0.012

Elapsed Time	INPUT 2
8.4000	-0.012
8.6000	-0.015
8.8000	-0.018
9.0000	-0.018
9.2000	-0.018
9.4000	-0.018
9.6000	-0.018
9.8000	-0.018
10.0000	-0.018
12.0000	-0.025
14.0000	-0.028
16.0000	-0.028
18.0000	-0.028
20.0000	-0.028
22.0000	-0.028
24.0000	-0.031
26.0000	-0.028
28.0000	-0.031
30.0000	-0.028
32.0000	-0.031
34.0000	-0.028
36.0000	-0.031
38.0000	-0.031
40.0000	-0.025
42.0000	-0.028
44.0000	-0.031
46.0000	-0.028
48.0000	-0.028



MODEL TYPE: BOUWER and RICE	for: USAEC	Well Slug Test Data
CONDUCTIVITY: .004985 ft/min	by: Ecology & Environment	Well: E3-P58-M02
TRANSMISSIVITY: .2074 sq. ft/min	WELL DATA Units: ft	SUDBURY, MA
INITIAL HEAD: 4.648 ft	AQUIFER: Endless	SUDBURY
Data Set: P58M2S0	THICKNESS: 41.61	
Date: 9-21-93	SCREEN: top: 40.00 base: 50.00	
	DIAMETER: casing: .3400 intake: .3400	
	DEPTH: Water Table: 8.600 TD: 50.21	

APPENDIX G-B
(SLUG TEST)

RISING HEAD DATA AND INTERPRETED GRAPHS
FORT DEVENS, MASSACHUSETTS SITE

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A02-M01X

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:53	Date	09/22 /93
Logger Test	5	INPUT 1 Level (F)	

Step 1 09/22 14:15:51

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-1.141	0.3250	-0.044
0.0083	-1.066	0.3333	-0.037
0.0166	-0.999	0.3500	-0.034
0.0250	-0.936	0.3666	-0.028
0.0333	-0.867	0.3833	-0.025
0.0416	-0.823	0.4000	-0.022
0.0500	-0.769	0.4166	-0.018
0.0583	-0.712	0.4333	-0.018
0.0666	-0.662	0.4500	-0.015
0.0750	-0.618	0.4666	-0.015
0.0833	-0.574	0.4833	-0.012
0.0916	-0.539	0.5000	-0.012
0.1000	-0.498	0.5166	-0.009
0.1083	-0.466	0.5333	-0.009
0.1166	-0.432	0.5500	-0.009
0.1250	-0.400	0.5666	-0.009
0.1333	-0.372	0.5833	-0.009
0.1416	-0.346	0.6000	-0.006
0.1500	-0.315	0.6166	-0.006
0.1583	-0.293	0.6333	-0.006
0.1666	-0.268	0.6500	-0.006
0.1750	-0.249	0.6666	-0.006
0.1833	-0.227	0.6833	-0.003
0.1916	-0.208	0.7000	-0.003
0.2000	-0.192	0.7166	-0.003
0.2083	-0.173	0.7333	-0.003
0.2166	-0.157	0.7500	-0.003
0.2250	-0.145	0.7666	-0.003
0.2333	-0.129	0.7833	-0.003
0.2416	-0.116	0.8000	-0.003
0.2500	-0.107	0.8166	0.000
0.2583	-0.097	0.8333	-0.003
0.2666	-0.085	0.8500	0.000
0.2750	-0.078	0.8666	0.000
0.2833	-0.069	0.8833	0.000
0.2916	-0.063	0.9000	0.000
0.3000	-0.056	0.9166	0.000
0.3083	-0.053	0.9333	0.000
0.3166	-0.047	0.9500	0.000

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A02-M01X

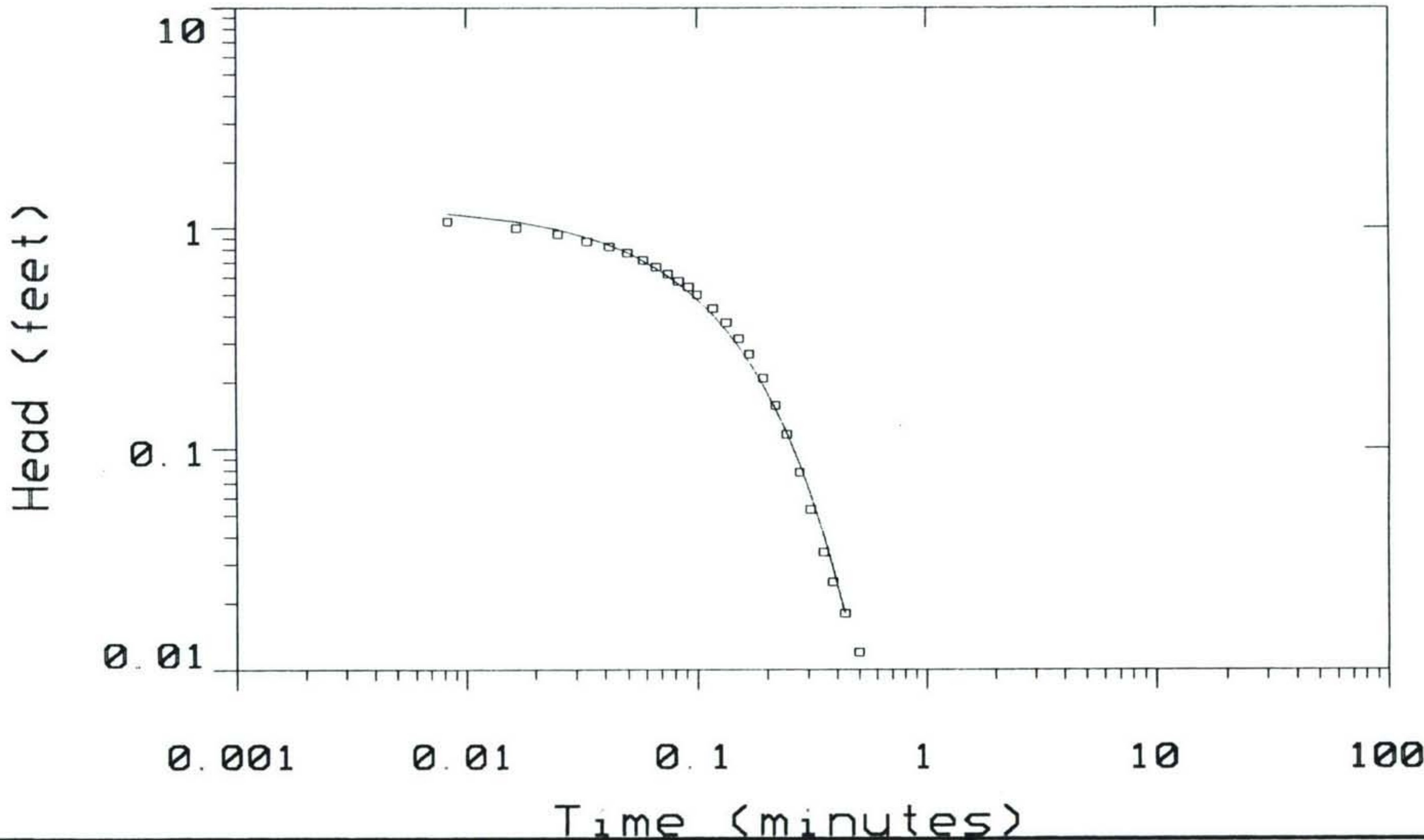
Reference	0.000
SG	1.000
Linearity	-0.000
Time	19:53
Logger Test	5

Scale Factor	9.990
Offset	-0.009
Delay mSEC	50.000
Date	09/22 /93
INPUT 1 Level (F)	

Step 1 09/22 14:15:51

Elapsed Time	INPUT 1
0.9666	0.000
0.9833	0.000
1.0000	0.000
1.2000	0.003
1.4000	0.003
1.6000	0.003
1.8000	0.003
2.0000	0.003
2.2000	0.003
2.4000	0.006
2.6000	0.003
2.8000	0.003
3.0000	0.003
3.2000	0.006
3.4000	0.003
3.6000	0.006
3.8000	0.006
4.0000	0.006
4.2000	0.003
4.4000	0.006
4.6000	0.006
4.8000	0.006
5.0000	0.003
5.2000	0.003
5.4000	0.006
5.6000	0.006
5.8000	0.006
6.0000	0.003
6.2000	0.003
6.4000	0.003
6.6000	0.003
6.8000	0.006
7.0000	0.003
7.2000	0.003
7.4000	0.006
7.6000	0.006
7.8000	0.006
8.0000	0.003
8.2000	0.006

Elapsed Time	INPUT 1
8.4000	0.003
8.6000	0.003
8.8000	0.006
9.0000	0.003
9.2000	0.003
9.4000	0.006
9.6000	0.003
9.8000	0.003
10.0000	0.003



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY 03266 ft/min	
TRANSMISSIVITY 2185 sq ft/min	
INITIAL HEAD 1 066 ft	
Data Set A2MIS1	Date 9-22-93

for: **USAEC**

by: Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 6 690

SCREEN top 8 000 base 18 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 13 58 TD 20 27

Well Slug Test Data

Well: E3-A02-M01

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A05-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:51	Date	09/20 /93
Logger Test	1	INPUT 1 Level (F)	

Step 1 09/20 16:38:05

Elapsed Time	INPUT 1
0.0000	-3.378
0.0083	-3.327
0.0166	-3.298
0.0250	-3.276
0.0333	-3.244
0.0416	-3.228
0.0500	-3.238
0.0583	-3.222
0.0666	-3.216
0.0750	-3.203
0.0833	-3.213
0.0916	-3.178
0.1000	-3.181
0.1083	-3.159
0.1166	-3.165
0.1250	-3.159
0.1333	-3.152
0.1416	-3.143
0.1500	-3.140
0.1583	-3.152
0.1666	-3.130
0.1750	-3.133
0.1833	-3.117
0.1916	-3.108
0.2000	-3.105
0.2083	-3.101
0.2166	-3.095
0.2250	-3.114
0.2333	-3.130
0.2416	-3.092
0.2500	-3.082
0.2583	-3.076
0.2666	-3.073
0.2750	-3.067
0.2833	-3.067
0.2916	-3.060
0.3000	-3.054
0.3083	-3.051
0.3166	-3.047

Elapsed Time	INPUT 1
0.3250	-3.044
0.3333	-3.038
0.3500	-3.032
0.3666	-3.025
0.3833	-3.016
0.4000	-3.009
0.4166	-3.003
0.4333	-2.997
0.4500	-2.990
0.4666	-2.984
0.4833	-2.978
0.5000	-2.971
0.5166	-2.965
0.5333	-2.959
0.5500	-2.952
0.5666	-2.946
0.5833	-2.940
0.6000	-2.933
0.6166	-2.930
0.6333	-2.924
0.6500	-2.917
0.6666	-2.911
0.6833	-2.908
0.7000	-2.901
0.7166	-2.895
0.7333	-2.892
0.7500	-2.886
0.7666	-2.879
0.7833	-2.876
0.8000	-2.870
0.8166	-2.863
0.8333	-2.860
0.8500	-2.854
0.8666	-2.851
0.8833	-2.844
0.9000	-2.841
0.9166	-2.835
0.9333	-2.828
0.9500	-2.825

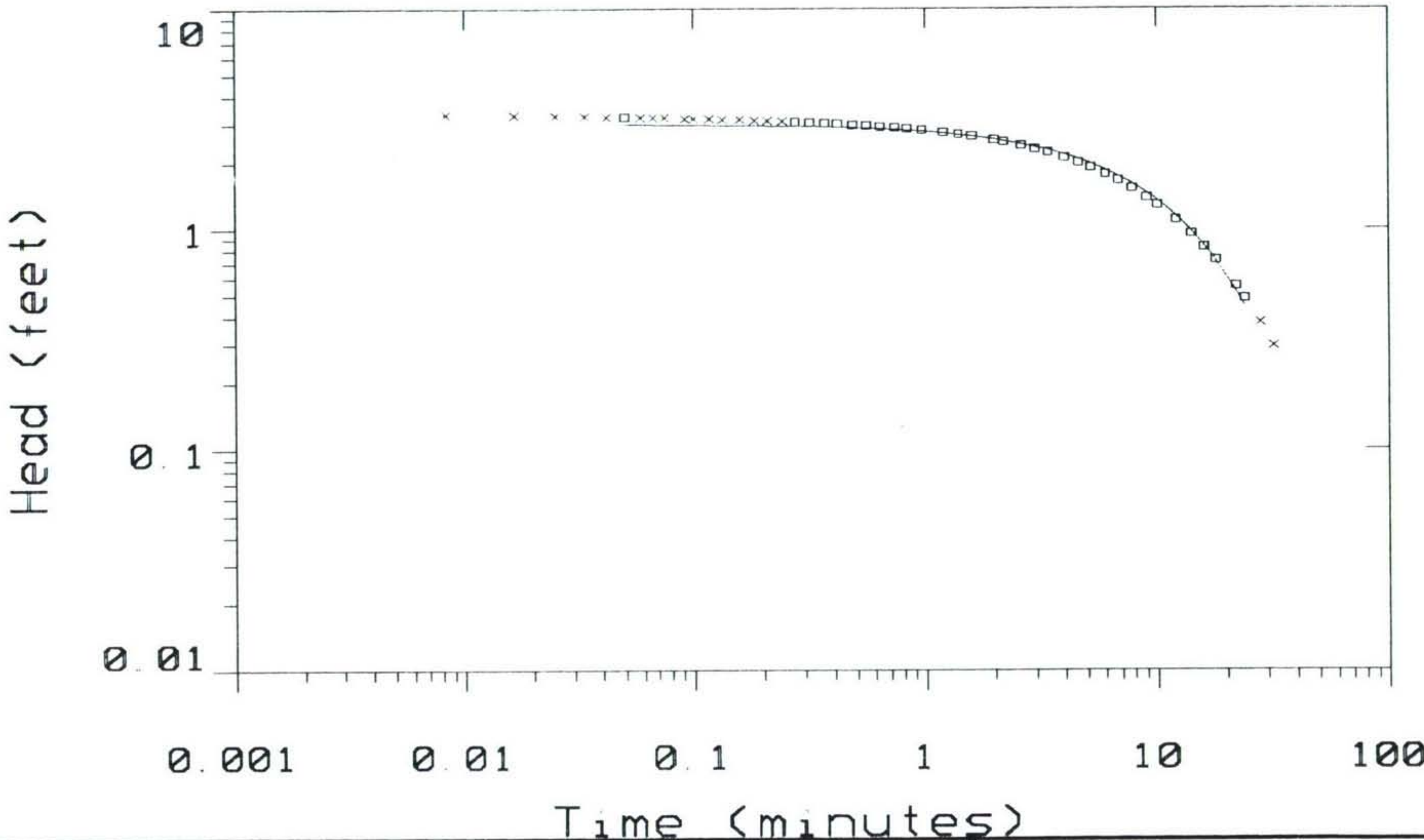
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A05-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:51	Date	09/20 /93
Logger Test	1	INPUT 1 Level (F)	

Step 1 09/20 16:38:05

Elapsed Time	INPUT 1
0.9666	-2.819
0.9833	-2.813
1.0000	-2.809
1.2000	-2.749
1.4000	-2.695
1.6000	-2.644
1.8000	-2.593
2.0000	-2.546
2.2000	-2.498
2.4000	-2.454
2.6000	-2.406
2.8000	-2.365
3.0000	-2.320
3.2000	-2.279
3.4000	-2.238
3.6000	-2.197
3.8000	-2.159
4.0000	-2.117
4.2000	-2.082
4.4000	-2.044
4.6000	-2.009
4.8000	-1.971
5.0000	-1.939
5.2000	-1.905
5.4000	-1.873
5.6000	-1.841
5.8000	-1.809
6.0000	-1.778
6.2000	-1.749
6.4000	-1.720
6.6000	-1.692
6.8000	-1.663
7.0000	-1.635
7.2000	-1.609
7.4000	-1.581
7.6000	-1.555
7.8000	-1.530
8.0000	-1.504
8.2000	-1.482

Elapsed Time	INPUT 1
8.4000	-1.460
8.6000	-1.435
8.8000	-1.412
9.0000	-1.390
9.2000	-1.368
9.4000	-1.346
9.6000	-1.327
9.8000	-1.304
10.0000	-1.285
12.0000	-1.101
14.0000	-0.955
16.0000	-0.828
18.0000	-0.720
20.0000	-0.631
22.0000	-0.552
24.0000	-0.485
26.0000	-0.428
28.0000	-0.377
30.0000	-0.336
32.0000	-0.295



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 0004339 ft/min

TRANSMISSIVITY 01692 sq ft/min

INITIAL HEAD 3 327 ft

Data Set E3A5S1 | Date 9-20-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 39 00

SCREEN top 40 00 base 50 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 12 38 TD 50 00

Well Slug Test Data

Well: E3-A05-M01

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A10-M01X

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	19:56		Date	09/22 /93
Logger Test	4		INPUT 1 Level (F)	

Step 1 09/22 12:55:32

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-0.384	0.3250	-0.387
0.0083	-0.593	0.3333	-0.387
0.0166	-1.155	0.3500	-0.384
0.0250	-2.056	0.3666	-0.384
0.0333	-2.443	0.3833	-0.380
0.0416	-2.285	0.4000	-0.380
0.0500	-2.091	0.4166	-0.380
0.0583	-1.866	0.4333	-0.377
0.0666	-1.609	0.4500	-0.377
0.0750	-1.231	0.4666	-0.377
0.0833	-1.069	0.4833	-0.374
0.0916	-0.872	0.5000	-0.374
0.1000	-0.514	0.5166	-0.374
0.1083	-0.342	0.5333	-0.374
0.1166	-0.374	0.5500	-0.371
0.1250	-0.441	0.5666	-0.371
0.1333	-0.533	0.5833	-0.371
0.1416	-0.555	0.6000	-0.371
0.1500	-0.545	0.6166	-0.371
0.1583	-0.495	0.6333	-0.371
0.1666	-0.491	0.6500	-0.371
0.1750	-0.488	0.6666	-0.371
0.1833	-0.479	0.6833	-0.371
0.1916	-0.472	0.7000	-0.368
0.2000	-0.463	0.7166	-0.368
0.2083	-0.453	0.7333	-0.368
0.2166	-0.498	0.7500	-0.368
0.2250	-0.498	0.7666	-0.368
0.2333	-0.491	0.7833	-0.368
0.2416	-0.472	0.8000	-0.364
0.2500	-0.472	0.8166	-0.368
0.2583	-0.469	0.8333	-0.364
0.2666	-0.447	0.8500	-0.364
0.2750	-0.431	0.8666	-0.364
0.2833	-0.418	0.8833	-0.364
0.2916	-0.409	0.9000	-0.364
0.3000	-0.409	0.9166	-0.364
0.3083	-0.396	0.9333	-0.364
0.3166	-0.390	0.9500	-0.364

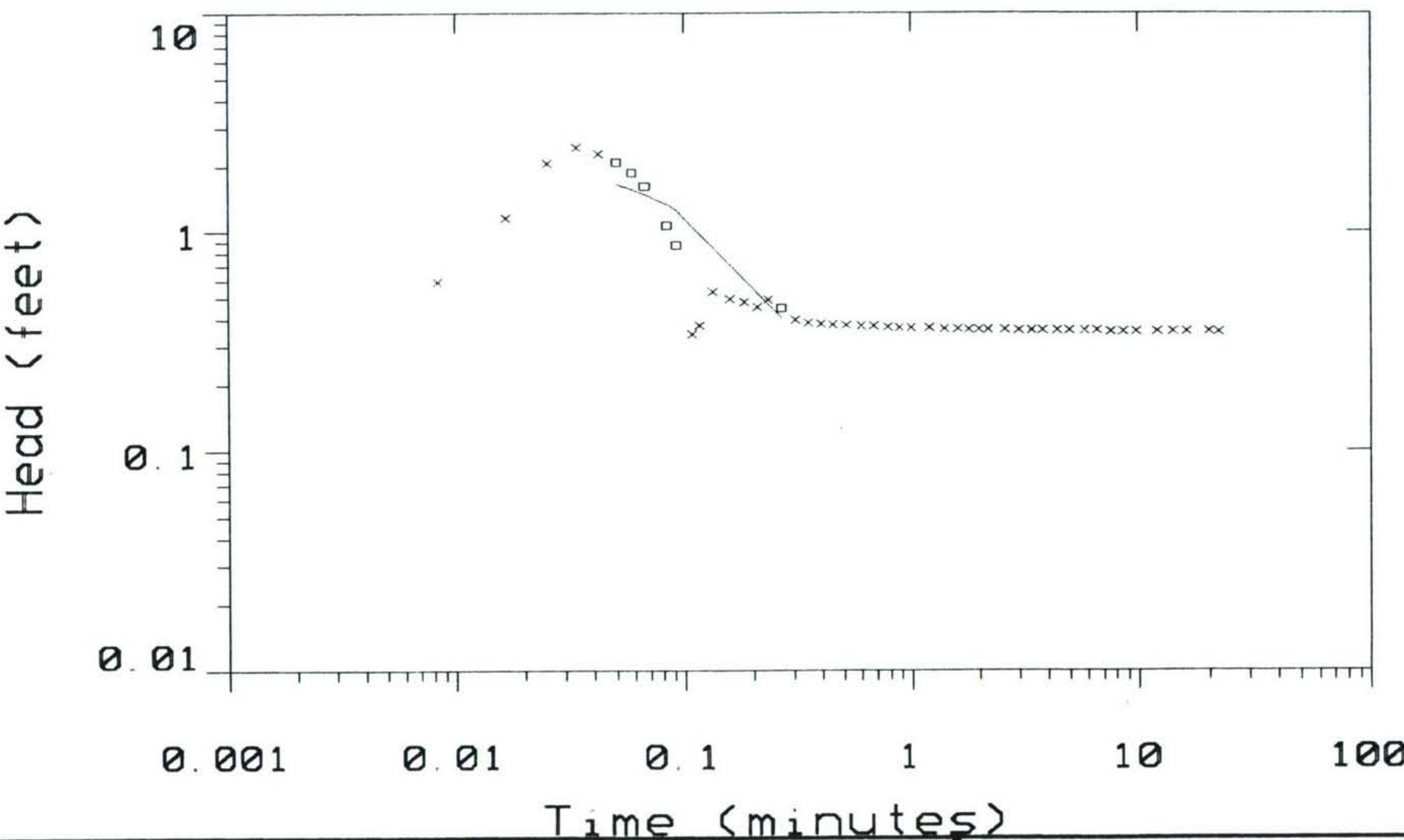
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-A10-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:56	Date	09/22 /93
Logger Test	4	INPUT 1 Level (F)	

Step 1 09/22 12:55:32

Elapsed Time	INPUT 1
0.9666	-0.364
0.9833	-0.364
1.0000	-0.364
1.2000	-0.364
1.4000	-0.361
1.6000	-0.361
1.8000	-0.358
2.0000	-0.358
2.2000	-0.358
2.4000	-0.358
2.6000	-0.358
2.8000	-0.358
3.0000	-0.355
3.2000	-0.355
3.4000	-0.355
3.6000	-0.355
3.8000	-0.355
4.0000	-0.355
4.2000	-0.355
4.4000	-0.355
4.6000	-0.355
4.8000	-0.355
5.0000	-0.355
5.2000	-0.355
5.4000	-0.355
5.6000	-0.355
5.8000	-0.355
6.0000	-0.355
6.2000	-0.355
6.4000	-0.355
6.6000	-0.355
6.8000	-0.355
7.0000	-0.352
7.2000	-0.355
7.4000	-0.352
7.6000	-0.352
7.8000	-0.352
8.0000	-0.352
8.2000	-0.352

Elapsed Time	INPUT 1
8.4000	-0.352
8.6000	-0.352
8.8000	-0.352
9.0000	-0.352
9.2000	-0.352
9.4000	-0.352
9.6000	-0.352
9.8000	-0.352
10.0000	-0.352
12.0000	-0.352
14.0000	-0.352
16.0000	-0.352
18.0000	-0.352
20.0000	-0.352
22.0000	-0.349



MODEL TYPE: BOUWER and RICE	
CONDUCTIVITY: .004620 ft/min	
TRANSMISSIVITY: .02772 sq. ft/min	
INITIAL HEAD: 5.930 ft	
Data Set: A10M1S1	Date: 9-22-93

for **USAEC**

by: Ecology & Environment

WELL DATA: Units: ft

AQUIFER: Endless

THICKNESS: 6.000

SCREEN: top: 8.500 base: 18.50

DIAMETER: casing: .3400 intake: .3400

DEPTH: Water Table: 14.82 TD: 20.82

Well Slug Test Data

Well: E3-A10-M01

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ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P02-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:48	Date	09/20 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/20 18:13:26

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-0.606	0.3250	-0.520
0.0083	-0.596	0.3333	-0.520
0.0166	-0.593	0.3500	-0.517
0.0250	-0.590	0.3666	-0.517
0.0333	-0.583	0.3833	-0.514
0.0416	-0.583	0.4000	-0.514
0.0500	-0.577	0.4166	-0.510
0.0583	-0.577	0.4333	-0.510
0.0666	-0.574	0.4500	-0.507
0.0750	-0.568	0.4666	-0.507
0.0833	-0.564	0.4833	-0.504
0.0916	-0.564	0.5000	-0.504
0.1000	-0.561	0.5166	-0.504
0.1083	-0.558	0.5333	-0.501
0.1166	-0.558	0.5500	-0.498
0.1250	-0.555	0.5666	-0.498
0.1333	-0.555	0.5833	-0.498
0.1416	-0.552	0.6000	-0.495
0.1500	-0.549	0.6166	-0.495
0.1583	-0.545	0.6333	-0.491
0.1666	-0.545	0.6500	-0.491
0.1750	-0.545	0.6666	-0.491
0.1833	-0.542	0.6833	-0.488
0.1916	-0.539	0.7000	-0.488
0.2000	-0.539	0.7166	-0.485
0.2083	-0.539	0.7333	-0.485
0.2166	-0.536	0.7500	-0.482
0.2250	-0.536	0.7666	-0.482
0.2333	-0.533	0.7833	-0.482
0.2416	-0.533	0.8000	-0.479
0.2500	-0.533	0.8166	-0.479
0.2583	-0.530	0.8333	-0.479
0.2666	-0.530	0.8500	-0.476
0.2750	-0.530	0.8666	-0.476
0.2833	-0.526	0.8833	-0.476
0.2916	-0.526	0.9000	-0.472
0.3000	-0.523	0.9166	-0.472
0.3083	-0.523	0.9333	-0.472
0.3166	-0.523	0.9500	-0.469

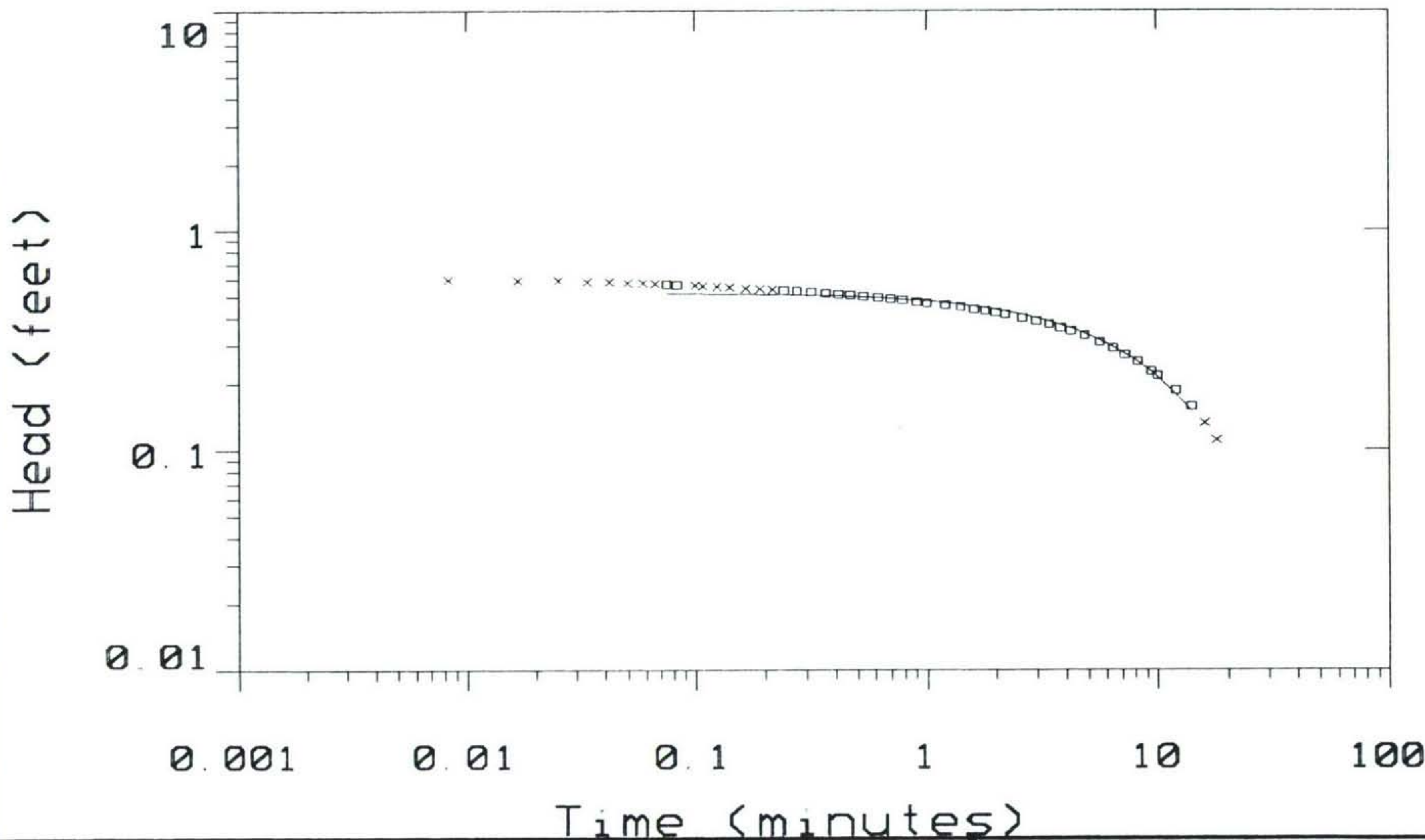
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P02-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:48	Date	09/20 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/20 18:13:26

Elapsed Time	INPUT 1
0.9666	-0.469
0.9833	-0.469
1.0000	-0.466
1.2000	-0.457
1.4000	-0.447
1.6000	-0.437
1.8000	-0.431
2.0000	-0.422
2.2000	-0.415
2.4000	-0.406
2.6000	-0.399
2.8000	-0.393
3.0000	-0.387
3.2000	-0.380
3.4000	-0.374
3.6000	-0.368
3.8000	-0.361
4.0000	-0.355
4.2000	-0.349
4.4000	-0.345
4.6000	-0.339
4.8000	-0.333
5.0000	-0.326
5.2000	-0.320
5.4000	-0.317
5.6000	-0.311
5.8000	-0.307
6.0000	-0.304
6.2000	-0.298
6.4000	-0.291
6.6000	-0.288
6.8000	-0.282
7.0000	-0.279
7.2000	-0.272
7.4000	-0.269
7.6000	-0.266
7.8000	-0.263
8.0000	-0.257
8.2000	-0.253

Elapsed Time	INPUT 1
8.4000	-0.250
8.6000	-0.247
8.8000	-0.241
9.0000	-0.238
9.2000	-0.234
9.4000	-0.228
9.6000	-0.225
9.8000	-0.222
10.0000	-0.218
12.0000	-0.187
14.0000	-0.158
16.0000	-0.133
18.0000	-0.111



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY 0003487 ft/min	
TRANSMISSIVITY 001981 sq ft/min	
INITIAL HEAD 5960 ft	
Data Set E3P2S1	Date 9-20-93

for USAEC
by Ecology & Environment
WELL DATA Units ft
AQUIFER Endless
THICKNESS 5 680
SCREEN top 10 00 base 20 00
DIAMETER casing 3400 intake 3400
DEPTH Water Table 15 35 TD 21 03

Well Slug Test Data

Well: E3-P02-M01

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ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:08	Date	09/21 /93
Logger Test	5	INPUT 1 Level (F)	

Step 1 09/21 16:38:03

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-2.070	0.3250	-1.451
0.0083	-2.063	0.3333	-1.438
0.0166	-1.974	0.3500	-1.428
0.0250	-1.955	0.3666	-1.419
0.0333	-1.898	0.3833	-1.406
0.0416	-1.867	0.4000	-1.400
0.0500	-1.835	0.4166	-1.393
0.0583	-1.803	0.4333	-1.384
0.0666	-1.774	0.4500	-1.378
0.0750	-1.752	0.4666	-1.368
0.0833	-1.730	0.4833	-1.362
0.0916	-1.705	0.5000	-1.355
0.1000	-1.689	0.5166	-1.349
0.1083	-1.670	0.5333	-1.343
0.1166	-1.651	0.5500	-1.333
0.1250	-1.638	0.5666	-1.327
0.1333	-1.625	0.5833	-1.320
0.1416	-1.609	0.6000	-1.314
0.1500	-1.597	0.6166	-1.308
0.1583	-1.587	0.6333	-1.301
0.1666	-1.578	0.6500	-1.295
0.1750	-1.568	0.6666	-1.289
0.1833	-1.555	0.6833	-1.282
0.1916	-1.549	0.7000	-1.279
0.2000	-1.536	0.7166	-1.273
0.2083	-1.533	0.7333	-1.266
0.2166	-1.524	0.7500	-1.260
0.2250	-1.517	0.7666	-1.254
0.2333	-1.508	0.7833	-1.251
0.2416	-1.505	0.8000	-1.244
0.2500	-1.498	0.8166	-1.238
0.2583	-1.489	0.8333	-1.232
0.2666	-1.489	0.8500	-1.228
0.2750	-1.482	0.8666	-1.222
0.2833	-1.476	0.8833	-1.216
0.2916	-1.473	0.9000	-1.212
0.3000	-1.466	0.9166	-1.206
0.3083	-1.460	0.9333	-1.203
0.3166	-1.479	0.9500	-1.197

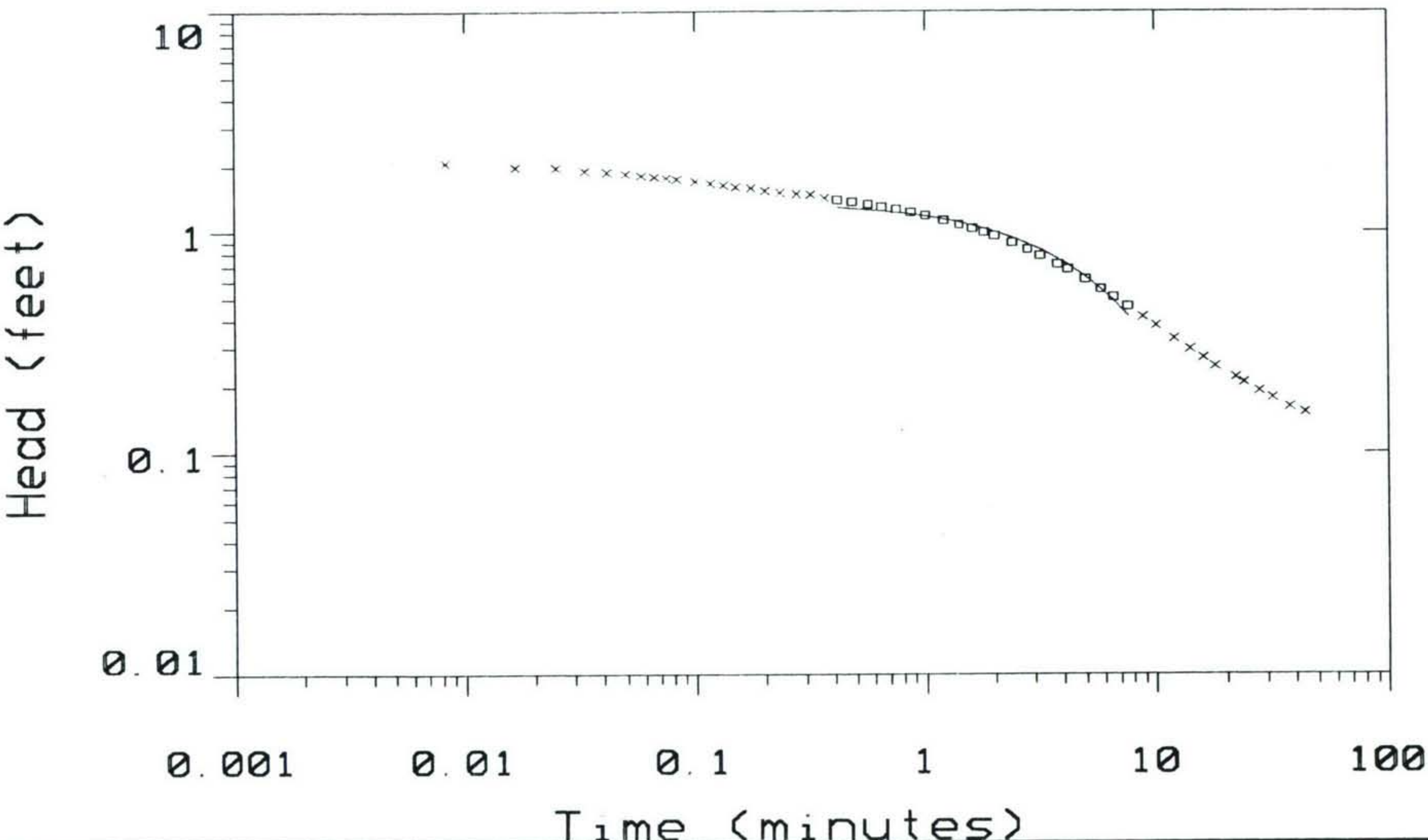
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:08	Date	09/21 /93
Logger Test	5	INPUT 1 Level (F)	

Step 1 09/21 16:38:03

Elapsed Time	INPUT 1
0.9666	-1.193
0.9833	-1.187
1.0000	-1.184
1.2000	-1.127
1.4000	-1.079
1.6000	-1.035
1.8000	-0.997
2.0000	-0.958
2.2000	-0.924
2.4000	-0.892
2.6000	-0.860
2.8000	-0.831
3.0000	-0.806
3.2000	-0.781
3.4000	-0.758
3.6000	-0.733
3.8000	-0.714
4.0000	-0.692
4.2000	-0.676
4.4000	-0.657
4.6000	-0.638
4.8000	-0.625
5.0000	-0.609
5.2000	-0.593
5.4000	-0.581
5.6000	-0.565
5.8000	-0.552
6.0000	-0.539
6.2000	-0.527
6.4000	-0.517
6.6000	-0.508
6.8000	-0.495
7.0000	-0.485
7.2000	-0.476
7.4000	-0.466
7.6000	-0.460
7.8000	-0.450
8.0000	-0.444
8.2000	-0.435

Elapsed Time	INPUT 1
8.4000	-0.428
8.6000	-0.419
8.8000	-0.412
9.0000	-0.406
9.2000	-0.400
9.4000	-0.393
9.6000	-0.387
9.8000	-0.381
10.0000	-0.377
12.0000	-0.330
14.0000	-0.295
16.0000	-0.269
18.0000	-0.247
20.0000	-0.231
22.0000	-0.219
24.0000	-0.209
26.0000	-0.196
28.0000	-0.190
30.0000	-0.184
32.0000	-0.177
34.0000	-0.171
36.0000	-0.168
38.0000	-0.161
40.0000	-0.158
42.0000	-0.155
44.0000	-0.152



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY 0006789 ft/min	
TRANSMISSIVITY 01518 sq ft/min	
INITIAL HEAD 2 063 ft	
Data Set P3M1S1	Date 9-21-93

for: **USAEC**
by: Ecology & Environment

WELL DATA Units ft
AQUIFER Endless
THICKNESS 22 36
SCREEN top 44 00 base 59 00
DIAMETER casing 3400 intake 3400
DEPTH Water Table 39 28 TD 61 64

Well Slug Test Data

Well: E3-P03-M01

SUDBURY, MA
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ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M02X

Reference	0.000
SG	1.000
Linearity	0.004
Time	07:39
Logger Test	1

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/23 /93
INPUT 1 Level (F)	

Step 1 09/22 08:33:30

Elapsed Time	INPUT 1
0.0000	-1.040
0.0083	-0.923
0.0166	-0.825
0.0250	-0.736
0.0333	-0.656
0.0416	-0.596
0.0500	-0.545
0.0583	-0.507
0.0666	-0.482
0.0750	-0.460
0.0833	-0.444
0.0916	-0.431
0.1000	-0.425
0.1083	-0.412
0.1166	-0.406
0.1250	-0.399
0.1333	-0.396
0.1416	-0.390
0.1500	-0.387
0.1583	-0.384
0.1666	-0.377
0.1750	-0.377
0.1833	-0.374
0.1916	-0.371
0.2000	-0.368
0.2083	-0.364
0.2166	-0.364
0.2250	-0.361
0.2333	-0.361
0.2416	-0.358
0.2500	-0.358
0.2583	-0.355
0.2666	-0.355
0.2750	-0.352
0.2833	-0.352
0.2916	-0.349
0.3000	-0.349
0.3083	-0.349
0.3166	-0.345
0.3250	-0.345
0.3333	-0.345
0.3500	-0.342
0.3666	-0.342
0.3833	-0.339
0.4000	-0.336
0.4166	-0.336
0.4333	-0.336
0.4500	-0.333
0.4666	-0.333
0.4833	-0.330
0.5000	-0.330
0.5166	-0.326
0.5333	-0.326
0.5500	-0.326
0.5666	-0.323
0.5833	-0.323
0.6000	-0.320
0.6166	-0.320
0.6333	-0.320
0.6500	-0.320
0.6666	-0.317
0.6833	-0.317
0.7000	-0.314
0.7166	-0.314
0.7333	-0.314
0.7500	-0.314
0.7666	-0.314
0.7833	-0.311
0.8000	-0.311
0.8166	-0.311
0.8333	-0.311
0.8500	-0.307
0.8666	-0.307
0.8833	-0.307
0.9000	-0.307
0.9166	-0.304
0.9333	-0.304
0.9500	-0.304

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P03-M02X

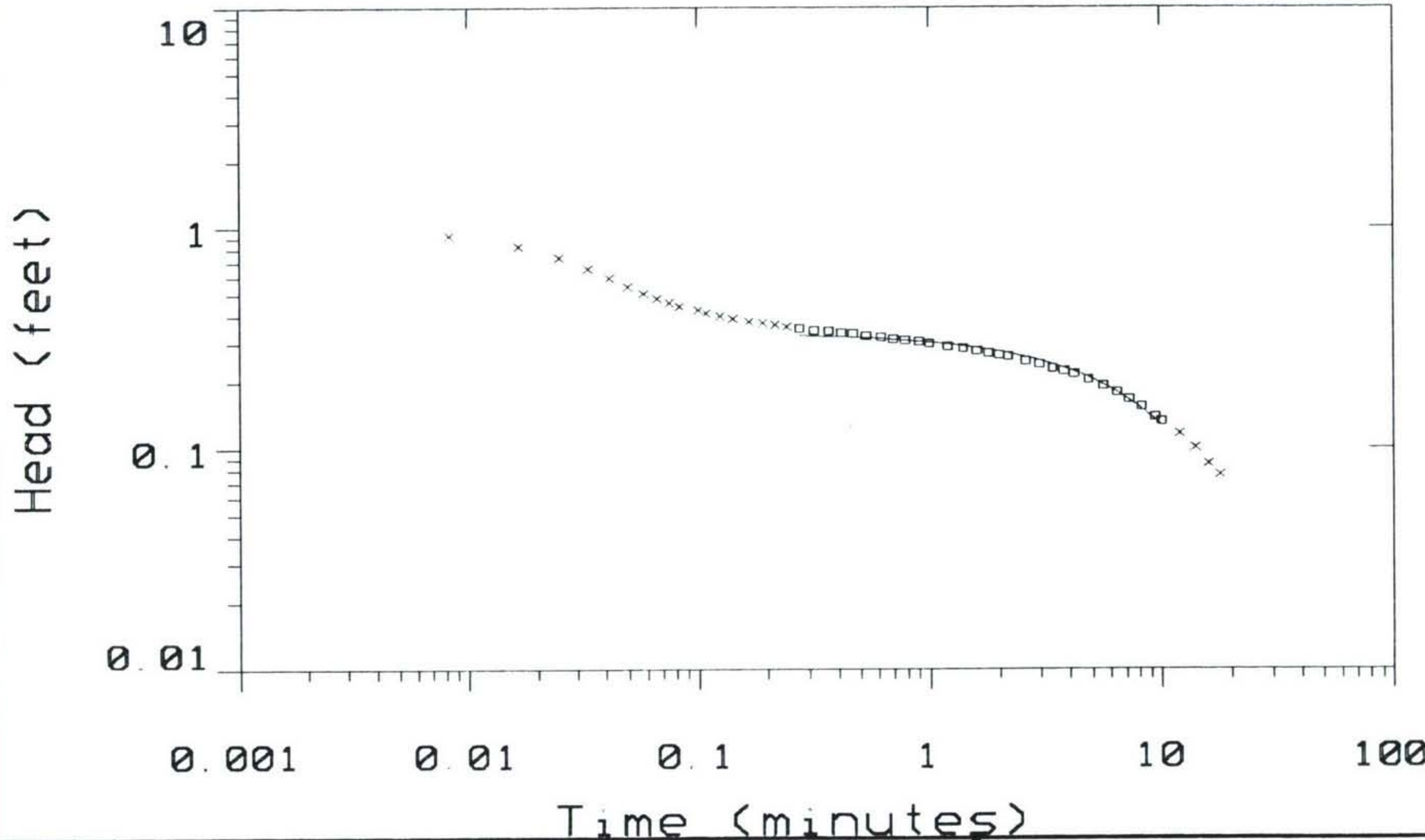
Reference	0.000
SG	1.000
Linearity	0.004
Time	07:39
Logger Test	1

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/23 /93
INPUT 1 Level (F)	

Step 1 09/22 08:33:30

Elapsed Time	INPUT 1
0.9666	-0.304
0.9833	-0.304
1.0000	-0.301
1.2000	-0.291
1.4000	-0.285
1.6000	-0.279
1.8000	-0.272
2.0000	-0.266
2.2000	-0.263
2.4000	-0.257
2.6000	-0.250
2.8000	-0.247
3.0000	-0.241
3.2000	-0.238
3.4000	-0.231
3.6000	-0.228
3.8000	-0.225
4.0000	-0.222
4.2000	-0.218
4.4000	-0.212
4.6000	-0.209
4.8000	-0.206
5.0000	-0.203
5.2000	-0.199
5.4000	-0.196
5.6000	-0.193
5.8000	-0.190
6.0000	-0.187
6.2000	-0.180
6.4000	-0.180
6.6000	-0.177
6.8000	-0.174
7.0000	-0.171
7.2000	-0.168
7.4000	-0.165
7.6000	-0.161
7.8000	-0.158
8.0000	-0.155
8.2000	-0.155

Elapsed Time	INPUT 1
8.4000	-0.152
8.6000	-0.149
8.8000	-0.145
9.0000	-0.145
9.2000	-0.142
9.4000	-0.139
9.6000	-0.139
9.8000	-0.136
10.0000	-0.133
12.0000	-0.117
14.0000	-0.101
16.0000	-0.085
18.0000	-0.076



MODEL TYPE: BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY: 0002246 ft/min	by Ecology & Environment	Well: E3-P03-M02
TRANSMISSIVITY: 001145 sq. ft/min	WELL DATA Units: ft	SUDBURY, MA
INITIAL HEAD: 9230 ft	AQUIFER: Endless	SUDBURY
Data Set: P3M2S1 Date: 9-22-93	THICKNESS: 5 100	
	SCREEN: top 7 500 base 15 50	
	DIAMETER: casing 1600 intake 1600	
	DEPTH: Water Table 11 83 TD 16 93	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P11-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:08	Date	09/23 /93
Logger Test	1	INPUT 1 Level (F)	

Step 1 09/23 09:17:42

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-3.094	0.3250	-1.755
0.0083	-3.021	0.3333	-1.739
0.0166	-2.942	0.3500	-1.714
0.0250	-2.891	0.3666	-1.691
0.0333	-2.837	0.3833	-1.666
0.0416	-2.767	0.4000	-1.647
0.0500	-2.713	0.4166	-1.625
0.0583	-2.659	0.4333	-1.606
0.0666	-2.615	0.4500	-1.587
0.0750	-2.571	0.4666	-1.568
0.0833	-2.523	0.4833	-1.549
0.0916	-2.475	0.5000	-1.533
0.1000	-2.431	0.5166	-1.517
0.1083	-2.393	0.5333	-1.501
0.1166	-2.355	0.5500	-1.485
0.1250	-2.317	0.5666	-1.472
0.1333	-2.279	0.5833	-1.460
0.1416	-2.244	0.6000	-1.450
0.1500	-2.202	0.6166	-1.441
0.1583	-2.177	0.6333	-1.431
0.1666	-2.133	0.6500	-1.422
0.1750	-2.107	0.6666	-1.415
0.1833	-2.075	0.6833	-1.406
0.1916	-2.053	0.7000	-1.399
0.2000	-2.025	0.7166	-1.393
0.2083	-2.006	0.7333	-1.387
0.2166	-1.980	0.7500	-1.380
0.2250	-1.961	0.7666	-1.377
0.2333	-1.936	0.7833	-1.371
0.2416	-1.917	0.8000	-1.368
0.2500	-1.898	0.8166	-1.361
0.2583	-1.879	0.8333	-1.358
0.2666	-1.860	0.8500	-1.355
0.2750	-1.844	0.8666	-1.352
0.2833	-1.828	0.8833	-1.349
0.2916	-1.812	0.9000	-1.345
0.3000	-1.796	0.9166	-1.342
0.3083	-1.783	0.9333	-1.339
0.3166	-1.768	0.9500	-1.336

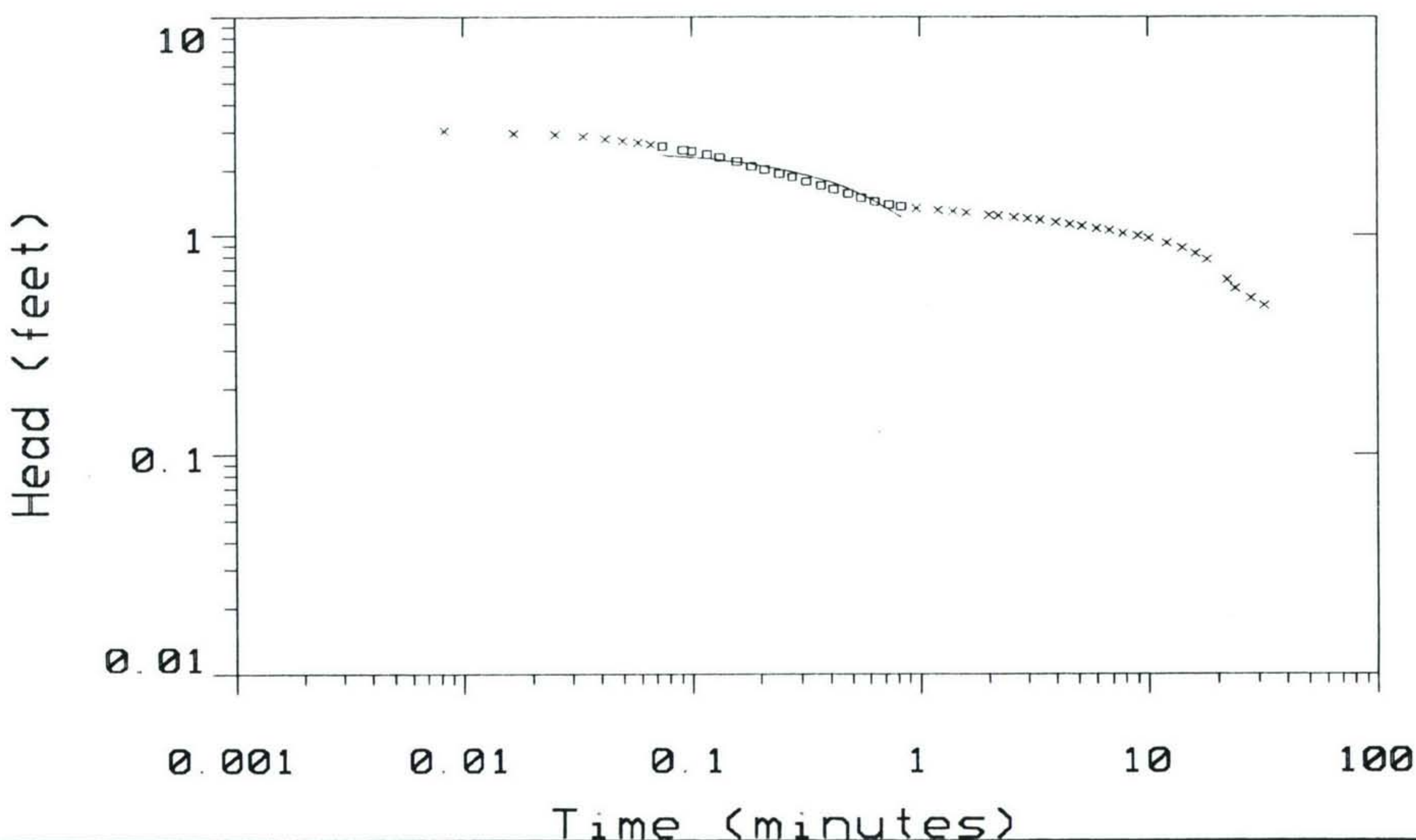
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P11-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:08	Date	09/23 /93
Logger Test	1	INPUT 1 Level (F)	

Step 1 09/23 09:17:42

Elapsed Time	INPUT 1
0.9666	-1.333
0.9833	-1.333
1.0000	-1.330
1.2000	-1.304
1.4000	-1.285
1.6000	-1.269
1.8000	-1.253
2.0000	-1.241
2.2000	-1.228
2.4000	-1.218
2.6000	-1.209
2.8000	-1.199
3.0000	-1.190
3.2000	-1.180
3.4000	-1.174
3.6000	-1.164
3.8000	-1.158
4.0000	-1.149
4.2000	-1.142
4.4000	-1.133
4.6000	-1.126
4.8000	-1.120
5.0000	-1.114
5.2000	-1.107
5.4000	-1.101
5.6000	-1.095
5.8000	-1.085
6.0000	-1.079
6.2000	-1.072
6.4000	-1.069
6.6000	-1.063
6.8000	-1.057
7.0000	-1.050
7.2000	-1.044
7.4000	-1.037
7.6000	-1.034
7.8000	-1.025
8.0000	-1.022
8.2000	-1.015

Elapsed Time	INPUT 1
8.4000	-1.009
8.6000	-1.006
8.8000	-0.999
9.0000	-0.993
9.2000	-0.990
9.4000	-0.984
9.6000	-0.977
9.8000	-0.974
10.0000	-0.968
12.0000	-0.920
14.0000	-0.876
16.0000	-0.828
18.0000	-0.777
20.0000	-0.707
22.0000	-0.625
24.0000	-0.574
26.0000	-0.542
28.0000	-0.517
30.0000	-0.498
32.0000	-0.479



MODEL TYPE: BOUWER and RICE

CONDUCTIVITY: .004169 ft/min

TRANSMISSIVITY: .03656 sq. ft/min

INITIAL HEAD: 3.021 ft

Data Set: P11MIS1 | Date: 9-23-93

for: **USAEC**

by: Ecology & Environment

WELL DATA Units: ft

AQUIFER: Endless

THICKNESS: 8.770

SCREEN: top 6.000 base 16.00

DIAMETER: casing .3400 intake .3400

DEPTH: Water Table 9.440 TD: 18.21

Well Slug Test Data

Well: E3-P11-M01

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M01X

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:42	Date	09/22 /93
Logger Test	7	INPUT 1 Level (F)	

Step 1 09/22 17:06:54

Elapsed Time	INPUT 1
0.0000	-1.274
0.0083	-1.255
0.0166	-1.226
0.0250	-1.207
0.0333	-1.192
0.0416	-1.176
0.0500	-1.160
0.0583	-1.141
0.0666	-1.122
0.0750	-1.110
0.0833	-1.097
0.0916	-1.081
0.1000	-1.069
0.1083	-1.053
0.1166	-1.040
0.1250	-1.028
0.1333	-1.018
0.1416	-1.006
0.1500	-0.990
0.1583	-0.980
0.1666	-0.971
0.1750	-0.958
0.1833	-0.949
0.1916	-0.939
0.2000	-0.930
0.2083	-0.917
0.2166	-0.908
0.2250	-0.898
0.2333	-0.886
0.2416	-0.879
0.2500	-0.870
0.2583	-0.861
0.2666	-0.851
0.2750	-0.842
0.2833	-0.832
0.2916	-0.823
0.3000	-0.813
0.3083	-0.807
0.3166	-0.797

Elapsed Time	INPUT 1
0.3250	-0.788
0.3333	-0.779
0.3500	-0.763
0.3666	-0.750
0.3833	-0.734
0.4000	-0.719
0.4166	-0.703
0.4333	-0.687
0.4500	-0.674
0.4666	-0.662
0.4833	-0.646
0.5000	-0.633
0.5166	-0.621
0.5333	-0.608
0.5500	-0.599
0.5666	-0.583
0.5833	-0.574
0.6000	-0.561
0.6166	-0.551
0.6333	-0.539
0.6500	-0.529
0.6666	-0.520
0.6833	-0.507
0.7000	-0.501
0.7166	-0.492
0.7333	-0.482
0.7500	-0.473
0.7666	-0.463
0.7833	-0.454
0.8000	-0.447
0.8166	-0.438
0.8333	-0.432
0.8500	-0.422
0.8666	-0.416
0.8833	-0.406
0.9000	-0.400
0.9166	-0.394
0.9333	-0.387
0.9500	-0.381

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M01X

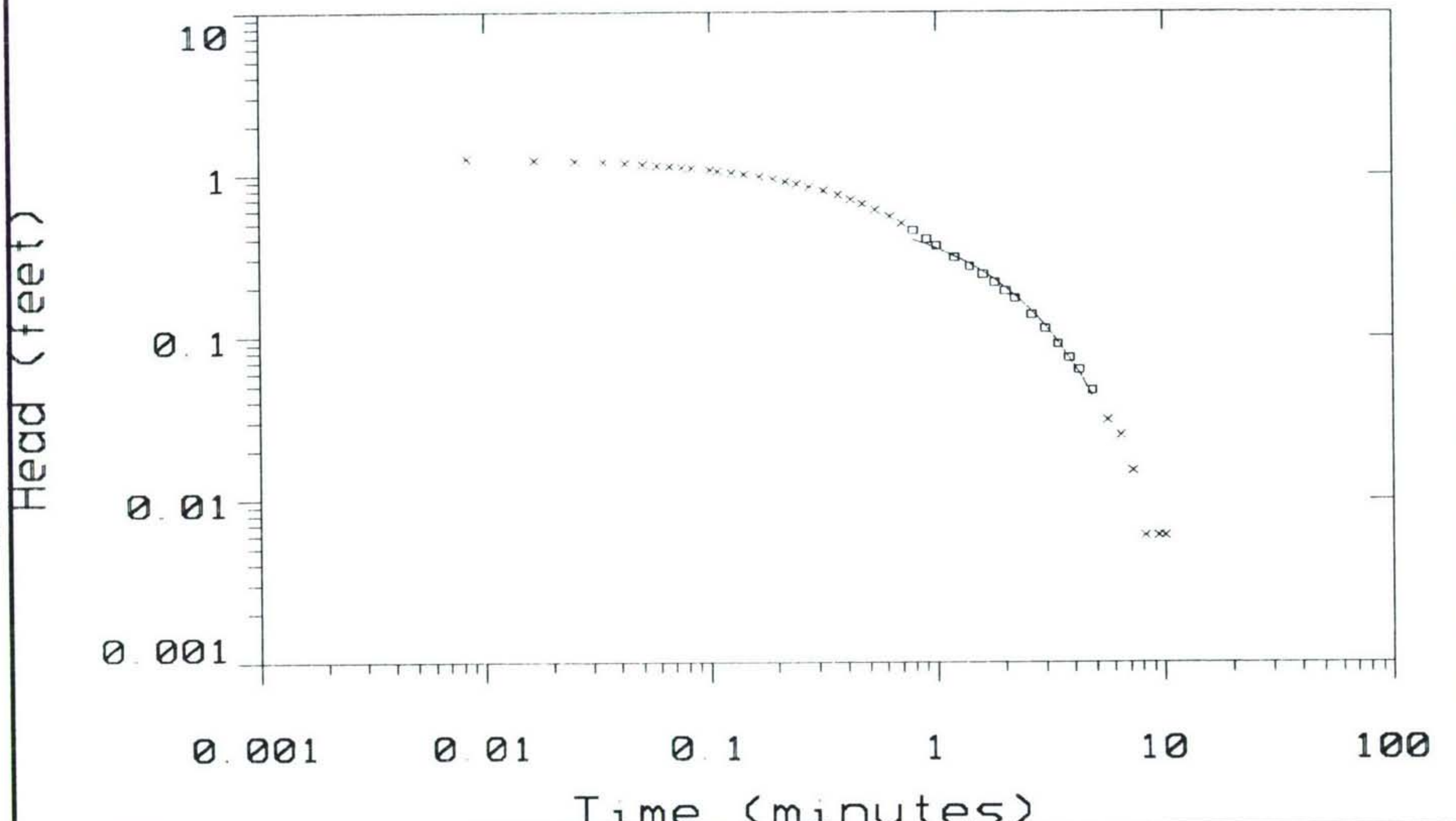
Reference	0.000
SG	1.000
Linearity	-0.000
Time	19:42
Logger Test	7

Scale Factor	9.990
Offset	-0.009
Delay mSEC	50.000
Date	09/22 /93
INPUT 1 Level (F)	

Step 1 09/22 17:06:54

Elapsed Time	INPUT 1
0.9666	-0.375
0.9833	-0.369
1.0000	-0.362
1.2000	-0.309
1.4000	-0.271
1.6000	-0.242
1.8000	-0.217
2.0000	-0.192
2.2000	-0.173
2.4000	-0.154
2.6000	-0.138
2.8000	-0.126
3.0000	-0.113
3.2000	-0.100
3.4000	-0.091
3.6000	-0.082
3.8000	-0.075
4.0000	-0.069
4.2000	-0.063
4.4000	-0.059
4.6000	-0.050
4.8000	-0.047
5.0000	-0.044
5.2000	-0.041
5.4000	-0.037
5.6000	-0.031
5.8000	-0.031
6.0000	-0.028
6.2000	-0.025
6.4000	-0.025
6.6000	-0.022
6.8000	-0.018
7.0000	-0.018
7.2000	-0.015
7.4000	-0.015
7.6000	-0.012
7.8000	-0.012
8.0000	-0.009
8.2000	-0.006

Elapsed Time	INPUT 1
8.4000	-0.009
8.6000	-0.009
8.8000	-0.006
9.0000	-0.009
9.2000	-0.006
9.4000	-0.006
9.6000	-0.006
9.8000	-0.003
10.0000	-0.006
12.0000	0.000
14.0000	0.000
16.0000	0.000
18.0000	0.006



MODEL TYPE: BOUWER and RICE	
CONDUCTIVITY .002455 ft/min	
TRANSMISSIVITY .01461 sq. ft/min	
INITIAL HEAD 1.255 ft	
Data Set P13M1S1	Date 9-22-93

for USAEC
by Ecology & Environment
WELL DATA Units ft
AQUIFER Endless
THICKNESS 5.950
SCREEN top 9.000 base 19.00
DIAMETER casing .3400 intake .3400
DEPTH Water Table 14.51 TD 20.46

Well Slug Test Data

Well: E3-P13-M01

SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M02X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:01	Date	09/23 /93
Logger Test	3	INPUT 1 Level (F)	

Step 1 09/23 11:48:26

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-1.111	0.3250	-0.485
0.0083	-0.638	0.3333	-0.466
0.0166	-1.679	0.3500	-0.434
0.0250	-2.692	0.3666	-0.409
0.0333	-2.876	0.3833	-0.384
0.0416	-2.615	0.4000	-0.358
0.0500	-2.435	0.4166	-0.339
0.0583	-2.269	0.4333	-0.320
0.0666	-2.120	0.4500	-0.304
0.0750	-1.981	0.4666	-0.288
0.0833	-1.860	0.4833	-0.276
0.0916	-1.752	0.5000	-0.263
0.1000	-1.657	0.5166	-0.250
0.1083	-1.542	0.5333	-0.238
0.1166	-1.568	0.5500	-0.228
0.1250	-1.466	0.5666	-0.219
0.1333	-1.308	0.5833	-0.209
0.1416	-1.447	0.6000	-0.203
0.1500	-1.193	0.6166	-0.193
0.1583	-1.123	0.6333	-0.187
0.1666	-1.069	0.6500	-0.177
0.1750	-1.015	0.6666	-0.171
0.1833	-0.965	0.6833	-0.165
0.1916	-0.923	0.7000	-0.161
0.2000	-0.879	0.7166	-0.152
0.2083	-0.841	0.7333	-0.149
0.2166	-0.803	0.7500	-0.142
0.2250	-0.768	0.7666	-0.139
0.2333	-0.739	0.7833	-0.136
0.2416	-0.707	0.8000	-0.130
0.2500	-0.679	0.8166	-0.126
0.2583	-0.650	0.8333	-0.123
0.2666	-0.628	0.8500	-0.120
0.2750	-0.603	0.8666	-0.117
0.2833	-0.581	0.8833	-0.114
0.2916	-0.558	0.9000	-0.111
0.3000	-0.539	0.9166	-0.107
0.3083	-0.520	0.9333	-0.107
0.3166	-0.501	0.9500	-0.104

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M02X

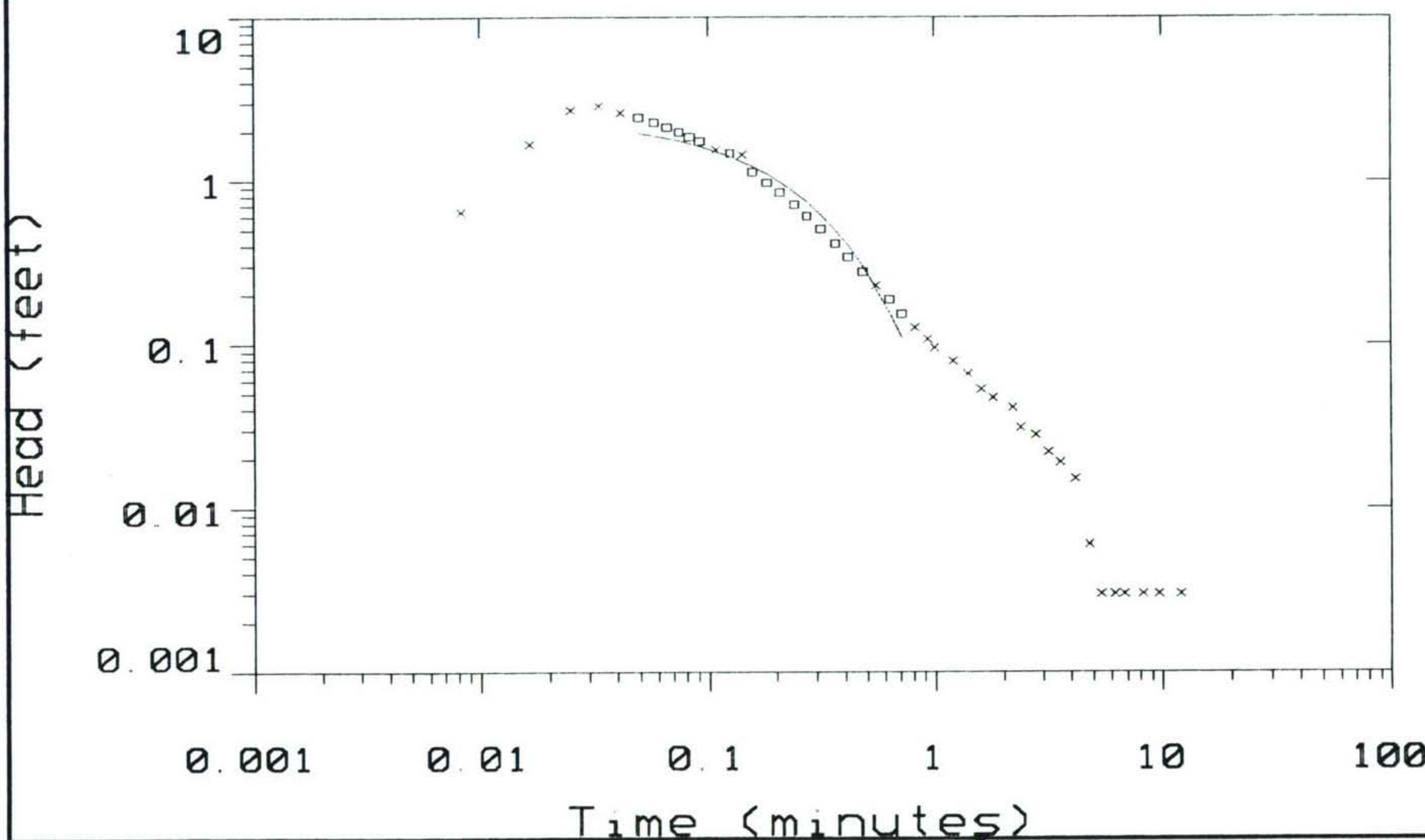
Reference	0.000
SG	1.000
Linearity	0.004
Time	20:01
Logger Test	3

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/23 /93
INPUT 1	Level (F)

Step 1 09/23 11:48:26

Elapsed Time	INPUT 1
0.9666	-0.101
0.9833	-0.098
1.0000	-0.095
1.2000	-0.079
1.4000	-0.066
1.6000	-0.053
1.8000	-0.047
2.0000	-0.041
2.2000	-0.041
2.4000	-0.031
2.6000	-0.034
2.8000	-0.028
3.0000	-0.025
3.2000	-0.022
3.4000	-0.022
3.6000	-0.019
3.8000	-0.019
4.0000	-0.015
4.2000	-0.015
4.4000	-0.012
4.6000	-0.009
4.8000	-0.006
5.0000	-0.006
5.2000	-0.003
5.4000	-0.003
5.6000	-0.003
5.8000	-0.003
6.0000	-0.003
6.2000	-0.003
6.4000	-0.003
6.6000	-0.003
6.8000	-0.003
7.0000	0.000
7.2000	0.000
7.4000	0.000
7.6000	-0.003
7.8000	-0.003
8.0000	0.000
8.2000	-0.003

Elapsed Time	INPUT 1
8.4000	-0.003
8.6000	0.000
8.8000	0.000
9.0000	0.000
9.2000	0.000
9.4000	0.000
9.6000	-0.003
9.8000	0.000
10.0000	0.000
12.0000	-0.003
14.0000	0.000
16.0000	0.000
18.0000	0.006
20.0000	0.003
22.0000	0.003
24.0000	0.000



MODEL TYPE: BOUWER and RICE	
CONDUCTIVITY: .01059 ft/min	
TRANSMISSIVITY: .1502 sq. ft/min	
INITIAL HEAD: .6380 ft	
Data Set: P13M2S1	Date: 9-23-93

for USAEC
by Ecology & Environment
WELL DATA Units: ft
AQUIFER: Endless
THICKNESS: 14.18
SCREEN: top 8.000 base 18.00
DIAMETER: casing .3400 intake .3400
DEPTH: Water Table 5.730 TD 19.91

Well Slug Test Data
Well: E3-P13-M02
SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M03X

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	19:58		Date	09/23 /93
Logger Test	4		INPUT 1 Level (F)	

Step 1 09/23 14:03:49

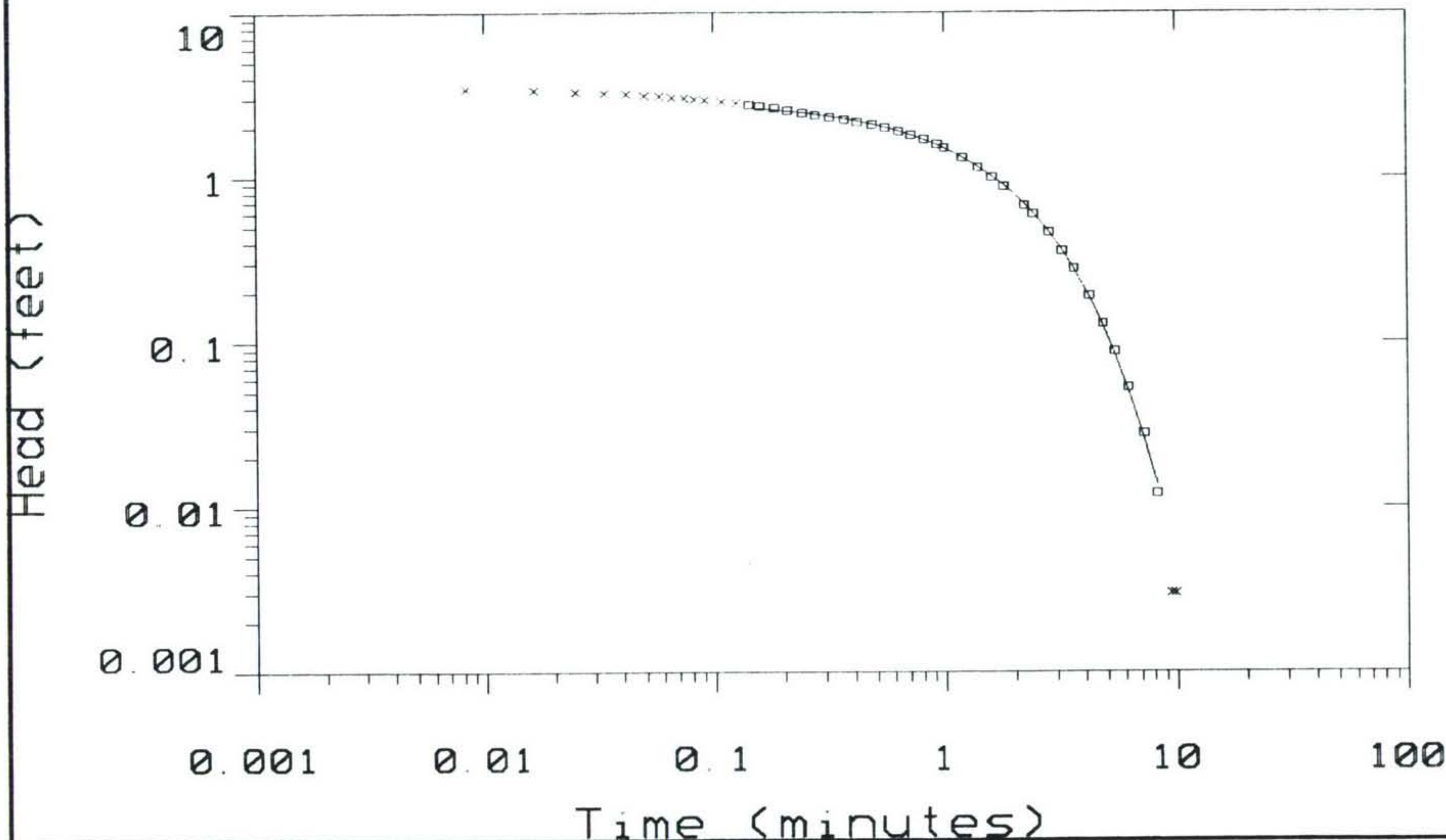
Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-3.152	0.3250	-2.295
0.0083	-3.440	0.3333	-2.282
0.0166	-3.380	0.3500	-2.260
0.0250	-3.304	0.3666	-2.241
0.0333	-3.244	0.3833	-2.203
0.0416	-3.202	0.4000	-2.183
0.0500	-3.133	0.4166	-2.161
0.0583	-3.110	0.4333	-2.142
0.0666	-3.053	0.4500	-2.120
0.0750	-3.031	0.4666	-2.101
0.0833	-2.977	0.4833	-2.085
0.0916	-2.942	0.5000	-2.066
0.1000	-2.910	0.5166	-2.047
0.1083	-2.869	0.5333	-2.028
0.1166	-2.841	0.5500	-2.009
0.1250	-2.812	0.5666	-1.990
0.1333	-2.780	0.5833	-1.968
0.1416	-2.748	0.6000	-1.945
0.1500	-2.729	0.6166	-1.926
0.1583	-2.701	0.6333	-1.907
0.1666	-2.682	0.6500	-1.885
0.1750	-2.650	0.6666	-1.866
0.1833	-2.631	0.6833	-1.847
0.1916	-2.590	0.7000	-1.828
0.2000	-2.564	0.7166	-1.809
0.2083	-2.542	0.7333	-1.790
0.2166	-2.523	0.7500	-1.771
0.2250	-2.501	0.7666	-1.752
0.2333	-2.479	0.7833	-1.736
0.2416	-2.456	0.8000	-1.717
0.2500	-2.437	0.8166	-1.701
0.2583	-2.422	0.8333	-1.685
0.2666	-2.403	0.8500	-1.669
0.2750	-2.383	0.8666	-1.653
0.2833	-2.368	0.8833	-1.638
0.2916	-2.352	0.9000	-1.622
0.3000	-2.336	0.9166	-1.606
0.3083	-2.323	0.9333	-1.587
0.3166	-2.307	0.9500	-1.568

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M03X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:58	Date	09/23 /93
Logger Test	4	INPUT 1 Level (F)	

Step 1 09/23 14:03:49

Elapsed Time	INPUT 1
0.9666	-1.549
0.9833	-1.533
1.0000	-1.514
1.2000	-1.314
1.4000	-1.145
1.6000	-1.003
1.8000	-0.879
2.0000	-0.771
2.2000	-0.676
2.4000	-0.596
2.6000	-0.523
2.8000	-0.460
3.0000	-0.403
3.2000	-0.358
3.4000	-0.317
3.6000	-0.279
3.8000	-0.247
4.0000	-0.219
4.2000	-0.190
4.4000	-0.168
4.6000	-0.146
4.8000	-0.130
5.0000	-0.114
5.2000	-0.101
5.4000	-0.088
5.6000	-0.079
5.8000	-0.069
6.0000	-0.060
6.2000	-0.053
6.4000	-0.047
6.6000	-0.044
6.8000	-0.034
7.0000	-0.034
7.2000	-0.028
7.4000	-0.022
7.6000	-0.022
7.8000	-0.015
8.0000	-0.015
8.2000	-0.012
8.4000	-0.012
8.6000	-0.009
8.8000	-0.006
9.0000	-0.006
9.2000	-0.006
9.4000	-0.003
9.6000	-0.003
9.8000	-0.003
10.0000	0.000
12.0000	0.006
14.0000	0.006
16.0000	0.003
18.0000	0.006
20.0000	0.006
22.0000	0.006
24.0000	0.006



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY .002889 ft/min	
TRANSMISSIVITY .03175 sq ft/min	
INITIAL HEAD 3.440 ft	
Data Set P13M3S1	Date 9-23-93

for **USAEC**

by Ecology & Environment

WELL DATA Units ft
AQUIFER Endless
THICKNESS 10.99
SCREEN top 8.000 base 18.00
DIAMETER casing .3400 intake .3400
DEPTH Water Table 7.670 TD 18.66

Well Slug Test Data

Well: E3-P13-M03

SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M04X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:05	Date	09/23 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/23 10:32:39

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-1.752	0.3250	-1.253
0.0083	-2.196	0.3333	-1.231
0.0166	-2.520	0.3500	-1.190
0.0250	-3.015	0.3666	-1.152
0.0333	-3.190	0.3833	-1.117
0.0416	-3.079	0.4000	-1.085
0.0500	-2.990	0.4166	-1.057
0.0583	-2.904	0.4333	-1.031
0.0666	-2.822	0.4500	-1.006
0.0750	-2.733	0.4666	-0.980
0.0833	-2.657	0.4833	-0.961
0.0916	-2.571	0.5000	-0.942
0.1000	-2.498	0.5166	-0.923
0.1083	-2.422	0.5333	-0.904
0.1166	-2.368	0.5500	-0.888
0.1250	-2.298	0.5666	-0.873
0.1333	-2.215	0.5833	-0.857
0.1416	-2.171	0.6000	-0.841
0.1500	-2.092	0.6166	-0.828
0.1583	-2.069	0.6333	-0.812
0.1666	-1.977	0.6500	-0.800
0.1750	-1.914	0.6666	-0.787
0.1833	-1.892	0.6833	-0.774
0.1916	-1.812	0.7000	-0.761
0.2000	-1.765	0.7166	-0.752
0.2083	-1.717	0.7333	-0.739
0.2166	-1.669	0.7500	-0.730
0.2250	-1.625	0.7666	-0.717
0.2333	-1.587	0.7833	-0.707
0.2416	-1.549	0.8000	-0.695
0.2500	-1.514	0.8166	-0.685
0.2583	-1.476	0.8333	-0.676
0.2666	-1.444	0.8500	-0.666
0.2750	-1.412	0.8666	-0.657
0.2833	-1.384	0.8833	-0.647
0.2916	-1.355	0.9000	-0.638
0.3000	-1.326	0.9166	-0.628
0.3083	-1.301	0.9333	-0.619
0.3166	-1.276	0.9500	-0.612

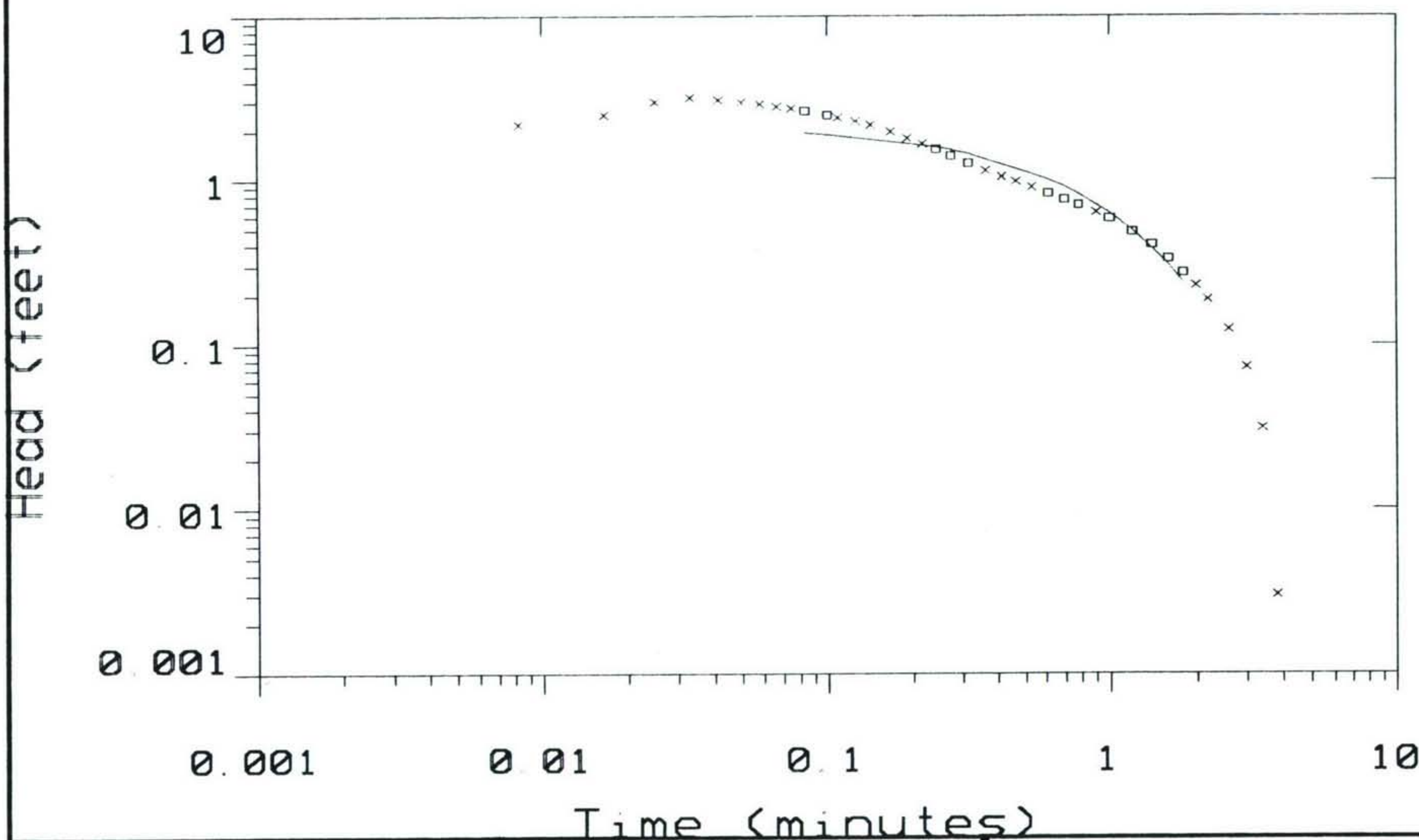
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P13-M04X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:05	Date	09/23 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/23 10:32:39

Elapsed Time	INPUT 1
0.9666	-0.603
0.9833	-0.593
1.0000	-0.584
1.2000	-0.485
1.4000	-0.403
1.6000	-0.333
1.8000	-0.273
2.0000	-0.228
2.2000	-0.187
2.4000	-0.152
2.6000	-0.123
2.8000	-0.098
3.0000	-0.073
3.2000	-0.053
3.4000	-0.031
3.6000	-0.015
3.8000	-0.003
4.0000	0.009
4.2000	0.012
4.4000	0.019
4.6000	0.025
4.8000	0.028
5.0000	0.034
5.2000	0.038
5.4000	0.044
5.6000	0.047
5.8000	0.047
6.0000	0.050
6.2000	0.050
6.4000	0.053
6.6000	0.053
6.8000	0.053
7.0000	0.057
7.2000	0.057
7.4000	0.060
7.6000	0.060
7.8000	0.060
8.0000	0.060
8.2000	0.060

Elapsed Time	INPUT 1
8.4000	0.060
8.6000	0.063
8.8000	0.060
9.0000	0.063
9.2000	0.060
9.4000	0.063
9.6000	0.063
9.8000	0.063
10.0000	0.063
12.0000	0.063
14.0000	0.066
16.0000	0.060
18.0000	0.057



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY .005143 ft/min	
TRANSMISSIVITY .05878 sq ft/min	
INITIAL HEAD 2.196 ft	
Data Set F13M4S1	Date 9-23-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 11.43

SCREEN top 8.600 base 18.60

DIAMETER casing .3400 intake .3400

DEPTH Water Table 8.730 TD 20.16

Well Slug Test Data

Well: E3-P13-M04

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P22-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:00	Date	09/22 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/22 09:38:25

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-1.761	0.3250	-1.098
0.0083	-1.733	0.3333	-1.095
0.0166	-1.288	0.3500	-1.088
0.0250	-1.234	0.3666	-1.079
0.0333	-1.149	0.3833	-1.076
0.0416	-1.600	0.4000	-1.073
0.0500	-1.495	0.4166	-1.069
0.0583	-1.327	0.4333	-1.066
0.0666	-1.174	0.4500	-1.063
0.0750	-1.076	0.4666	-1.060
0.0833	-1.222	0.4833	-1.057
0.0916	-1.454	0.5000	-1.057
0.1000	-1.425	0.5166	-1.054
0.1083	-1.523	0.5333	-1.054
0.1166	-1.406	0.5500	-1.054
0.1250	-1.320	0.5666	-1.050
0.1333	-1.279	0.5833	-1.050
0.1416	-1.234	0.6000	-1.050
0.1500	-1.263	0.6166	-1.050
0.1583	-1.441	0.6333	-1.050
0.1666	-1.371	0.6500	-1.050
0.1750	-1.333	0.6666	-1.050
0.1833	-1.304	0.6833	-1.050
0.1916	-1.279	0.7000	-1.050
0.2000	-1.257	0.7166	-1.050
0.2083	-1.238	0.7333	-1.050
0.2166	-1.219	0.7500	-1.050
0.2250	-1.203	0.7666	-1.050
0.2333	-1.187	0.7833	-1.047
0.2416	-1.177	0.8000	-1.047
0.2500	-1.165	0.8166	-1.047
0.2583	-1.155	0.8333	-1.047
0.2666	-1.155	0.8500	-1.047
0.2750	-1.136	0.8666	-1.047
0.2833	-1.127	0.8833	-1.047
0.2916	-1.123	0.9000	-1.047
0.3000	-1.114	0.9166	-1.047
0.3083	-1.107	0.9333	-1.047
0.3166	-1.104	0.9500	-1.047

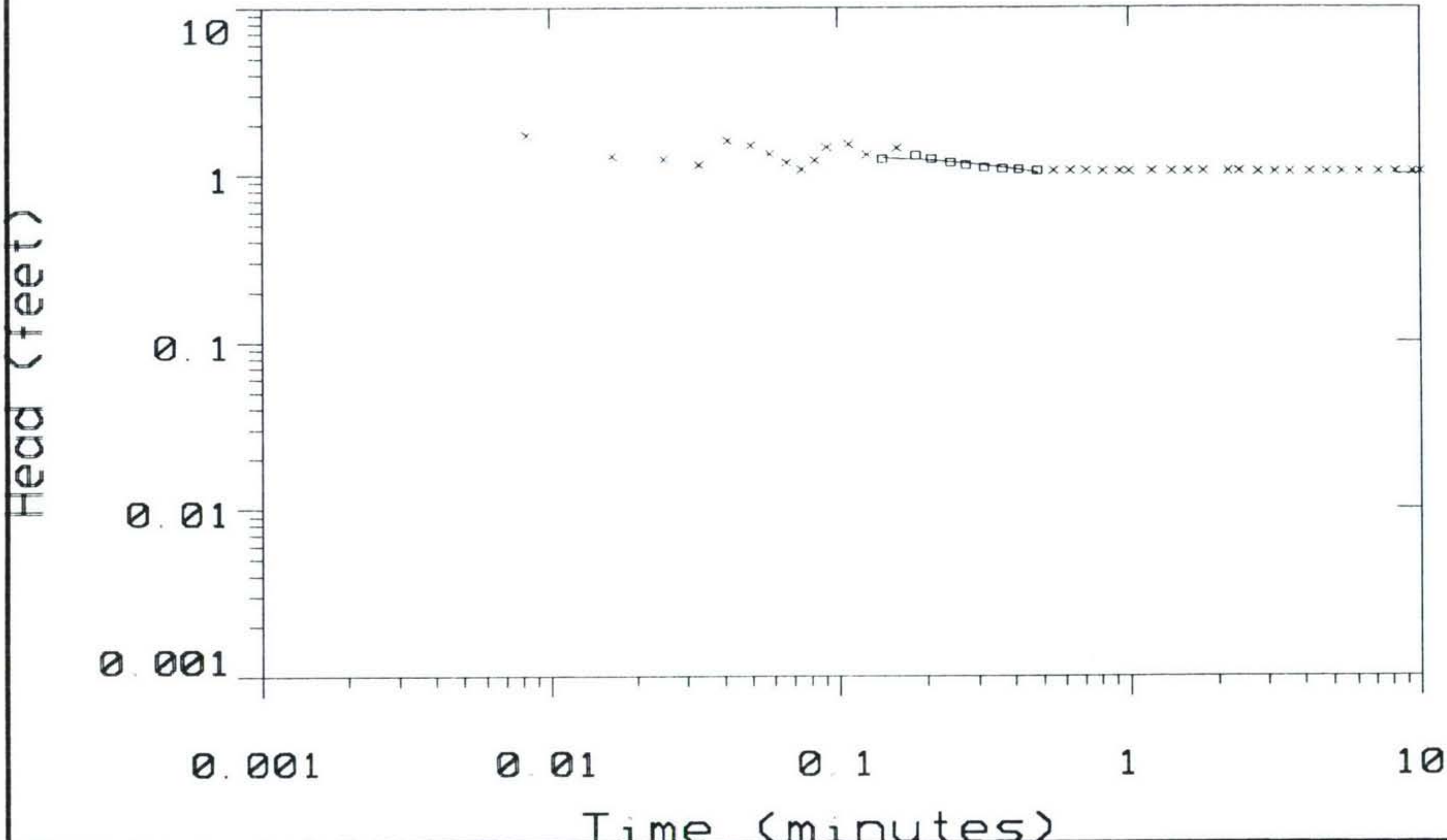
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P22-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:00	Date	09/22 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/22 09:38:25

Elapsed Time	INPUT 1
0.9666	-1.047
0.9833	-1.047
1.0000	-1.047
1.2000	-1.044
1.4000	-1.044
1.6000	-1.044
1.8000	-1.041
2.0000	-1.041
2.2000	-1.041
2.4000	-1.041
2.6000	-1.041
2.8000	-1.038
3.0000	-1.038
3.2000	-1.038
3.4000	-1.038
3.6000	-1.034
3.8000	-1.034
4.0000	-1.034
4.2000	-1.034
4.4000	-1.034
4.6000	-1.034
4.8000	-1.034
5.0000	-1.034
5.2000	-1.034
5.4000	-1.034
5.6000	-1.034
5.8000	-1.034
6.0000	-1.034
6.2000	-1.034
6.4000	-1.034
6.6000	-1.034
6.8000	-1.034
7.0000	-1.034
7.2000	-1.034
7.4000	-1.034
7.6000	-1.034
7.8000	-1.034
8.0000	-1.034
8.2000	-1.034

Elapsed Time	INPUT 1
8.4000	-1.034
8.6000	-1.034
8.8000	-1.034
9.0000	-1.034
9.2000	-1.034
9.4000	-1.034
9.6000	-1.034
9.8000	-1.038
10.0000	-1.034
12.0000	-1.034
14.0000	-1.034
16.0000	-1.034
18.0000	-1.034
20.0000	-1.034
22.0000	-1.034
24.0000	-1.095



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 004528 ft/min	by Ecology & Environment	Well: E3-P22-M01
TRANSMISSIVITY 05624 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 1 733 ft	AQUIFER Endless	SUDBURY
Data Set P22M1S1	THICKNESS 12 42	
Date 9-22-93	SCREEN top 8 000 base 18 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 7 490 TD 19 91	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P23-M01X

Reference	0.000
SG	1.000
Linearity	-0.000
Time	19:47
Logger Test	6

Scale Factor	9.990
Offset	-0.009
Delay mSEC	50.000
Date	09/22 /93
INPUT 1 Level (F)	

Step 1 09/22 15:22:54

Elapsed Time	INPUT 1
0.0000	-0.167
0.0083	-0.154
0.0166	-0.141
0.0250	-0.132
0.0333	-0.123
0.0416	-0.116
0.0500	-0.107
0.0583	-0.104
0.0666	-0.094
0.0750	-0.091
0.0833	-0.085
0.0916	-0.082
0.1000	-0.075
0.1083	-0.072
0.1166	-0.069
0.1250	-0.063
0.1333	-0.063
0.1416	-0.056
0.1500	-0.053
0.1583	-0.053
0.1666	-0.050
0.1750	-0.047
0.1833	-0.044
0.1916	-0.037
0.2000	-0.034
0.2083	-0.034
0.2166	-0.031
0.2250	-0.031
0.2333	-0.028
0.2416	-0.028
0.2500	-0.025
0.2583	-0.025
0.2666	-0.022
0.2750	-0.022
0.2833	-0.018
0.2916	-0.018
0.3000	-0.018
0.3083	-0.015
0.3166	-0.015

Elapsed Time	INPUT 1
0.3250	-0.015
0.3333	-0.015
0.3500	-0.012
0.3666	-0.012
0.3833	-0.009
0.4000	-0.009
0.4166	-0.009
0.4333	-0.006
0.4500	-0.006
0.4666	-0.006
0.4833	-0.003
0.5000	-0.003
0.5166	-0.003
0.5333	-0.003
0.5500	0.000
0.5666	-0.003
0.5833	-0.003
0.6000	0.000
0.6166	0.000
0.6333	0.000
0.6500	0.000
0.6666	0.000
0.6833	0.000
0.7000	0.000
0.7166	0.000
0.7333	0.003
0.7500	0.000
0.7666	0.003
0.7833	0.003
0.8000	0.003
0.8166	0.003
0.8333	0.003
0.8500	0.003
0.8666	0.003
0.8833	0.003
0.9000	0.003
0.9166	0.003
0.9333	0.003
0.9500	0.003

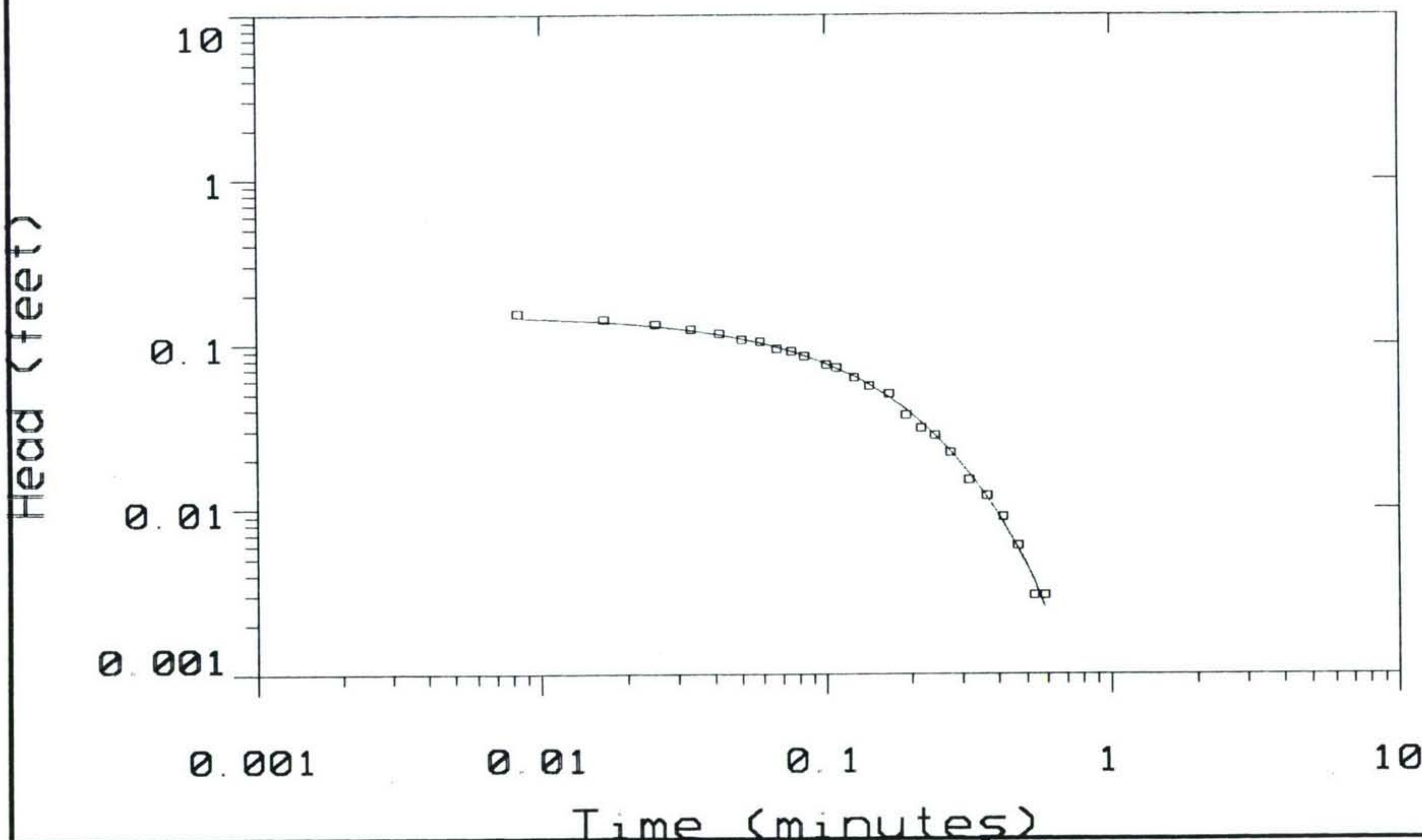
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P23-M01X

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	19:47	Date	09/22 /93
Logger Test	6	INPUT 1 Level (F)	

Step 1 09/22 15:22:54

Elapsed Time	INPUT 1
0.9666	0.003
0.9833	0.003
1.0000	0.003
1.2000	0.003
1.4000	0.006
1.6000	0.006
1.8000	0.006
2.0000	0.006
2.2000	0.006
2.4000	0.006
2.6000	0.006
2.8000	0.006
3.0000	0.006
3.2000	0.006
3.4000	0.006
3.6000	0.006
3.8000	0.006
4.0000	0.006
4.2000	0.006
4.4000	0.006
4.6000	0.006
4.8000	0.006
5.0000	0.006
5.2000	0.006
5.4000	0.006
5.6000	0.006
5.8000	0.006
6.0000	0.006
6.2000	0.006
6.4000	0.006
6.6000	0.006
6.8000	0.006
7.0000	0.006
7.2000	0.006
7.4000	0.006
7.6000	0.006
7.8000	0.006
8.0000	0.006
8.2000	0.006

Elapsed Time	INPUT 1
8.4000	0.006
8.6000	0.006
8.8000	0.006
9.0000	0.006
9.2000	0.006
9.4000	0.006
9.6000	0.006
9.8000	0.006
10.0000	0.006
12.0000	0.006
14.0000	0.006
16.0000	0.006
18.0000	0.003



MODEL TYPE: BOUWER and RICE	
CONDUCTIVITY: .02542 ft/min	
TRANSMISSIVITY: .1713 sq. ft/min	
INITIAL HEAD: .1540 ft	
Data Set: P23M1S1	Date: 9-22-93

for: USAEC
by: Ecology & Environment

WELL DATA: Units: ft
AQUIFER: Endless
THICKNESS: 6.740
SCREEN: top: 9.600 base: 19.60
DIAMETER: casing: .3400 intake: .3400
DEPTH: Water Table: 14.44 TD: 21.18

Well Slug Test Data

Well: E3-P23-M01
SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M01X

Reference	0.000
SG	1.000
Linearity	0.004
Time	11:52
Logger Test	2

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/24 /93
INPUT 1	Level (F)

Step 1 09/24 10:19:36

Elapsed Time	INPUT 1
0.0000	-2.911
0.0083	-2.822
0.0166	-2.736
0.0250	-2.653
0.0333	-2.577
0.0416	-2.504
0.0500	-2.447
0.0583	-2.387
0.0666	-2.317
0.0750	-2.250
0.0833	-2.187
0.0916	-2.123
0.1000	-2.066
0.1083	-2.009
0.1166	-1.955
0.1250	-1.914
0.1333	-1.869
0.1416	-1.819
0.1500	-1.771
0.1583	-1.723
0.1666	-1.679
0.1750	-1.638
0.1833	-1.584
0.1916	-1.568
0.2000	-1.565
0.2083	-1.533
0.2166	-1.495
0.2250	-1.460
0.2333	-1.422
0.2416	-1.387
0.2500	-1.355
0.2583	-1.323
0.2666	-1.288
0.2750	-1.257
0.2833	-1.228
0.2916	-1.200
0.3000	-1.171
0.3083	-1.146
0.3166	-1.117

Elapsed Time	INPUT 1
0.3250	-1.088
0.3333	-1.063
0.3500	-1.015
0.3666	-0.971
0.3833	-0.923
0.4000	-0.885
0.4166	-0.844
0.4333	-0.806
0.4500	-0.771
0.4666	-0.739
0.4833	-0.707
0.5000	-0.679
0.5166	-0.647
0.5333	-0.622
0.5500	-0.596
0.5666	-0.574
0.5833	-0.549
0.6000	-0.530
0.6166	-0.507
0.6333	-0.488
0.6500	-0.469
0.6666	-0.453
0.6833	-0.434
0.7000	-0.419
0.7166	-0.406
0.7333	-0.390
0.7500	-0.377
0.7666	-0.365
0.7833	-0.352
0.8000	-0.339
0.8166	-0.330
0.8333	-0.317
0.8500	-0.307
0.8666	-0.298
0.8833	-0.288
0.9000	-0.279
0.9166	-0.269
0.9333	-0.266
0.9500	-0.257

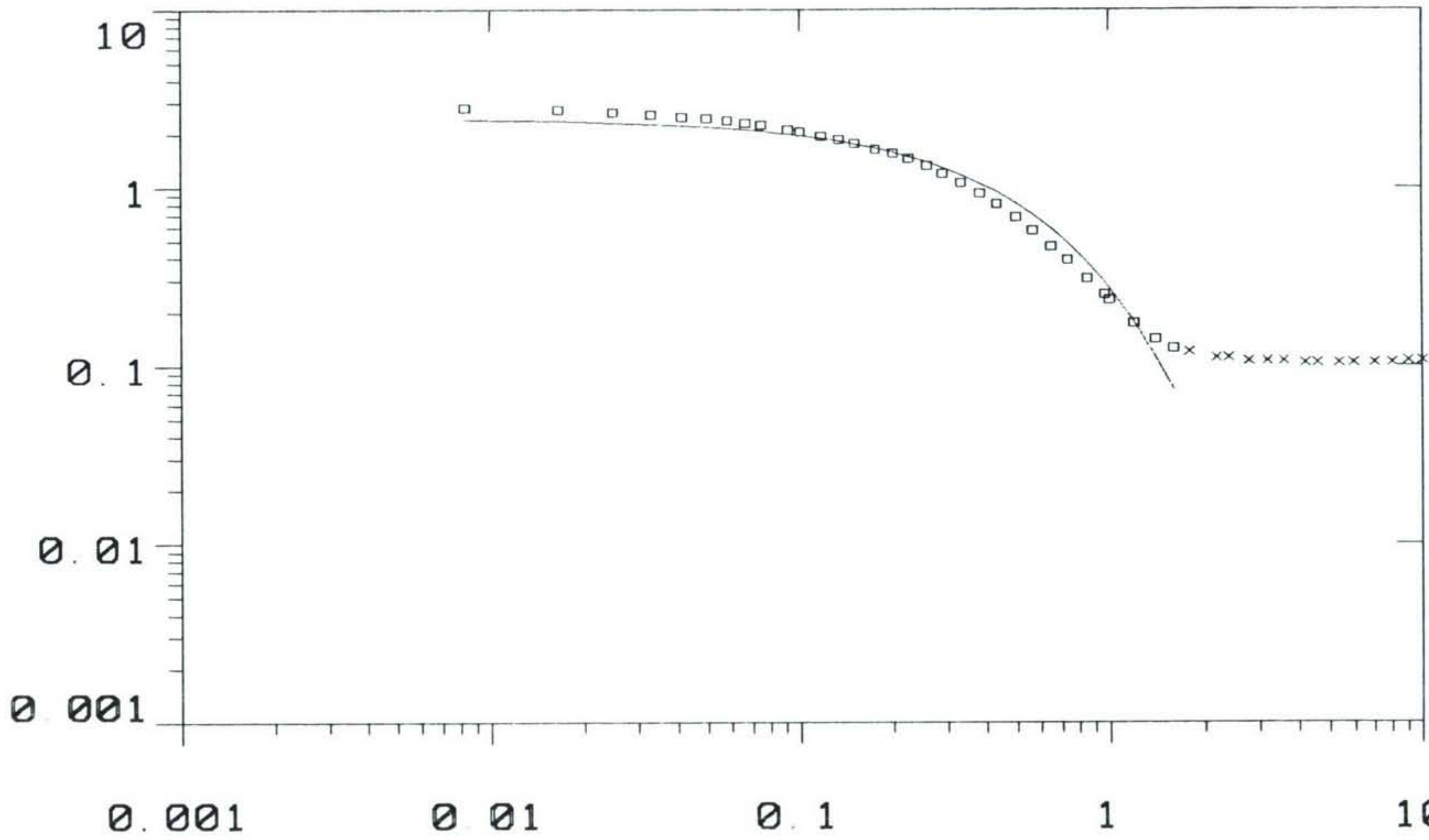
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	11:52	Date	09/24 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/24 10:19:36

Elapsed Time	INPUT 1
0.9666	-0.250
0.9833	-0.241
1.0000	-0.234
1.2000	-0.174
1.4000	-0.142
1.6000	-0.126
1.8000	-0.120
2.0000	-0.114
2.2000	-0.111
2.4000	-0.111
2.6000	-0.107
2.8000	-0.107
3.0000	-0.107
3.2000	-0.107
3.4000	-0.107
3.6000	-0.107
3.8000	-0.107
4.0000	-0.107
4.2000	-0.104
4.4000	-0.104
4.6000	-0.104
4.8000	-0.104
5.0000	-0.104
5.2000	-0.101
5.4000	-0.104
5.6000	-0.104
5.8000	-0.104
6.0000	-0.104
6.2000	-0.104
6.4000	-0.104
6.6000	-0.104
6.8000	-0.101
7.0000	-0.104
7.2000	-0.104
7.4000	-0.107
7.6000	-0.107
7.8000	-0.104
8.0000	-0.104
8.2000	-0.107

Elapsed Time	INPUT 1
8.4000	-0.104
8.6000	-0.104
8.8000	-0.104
9.0000	-0.107
9.2000	-0.101
9.4000	-0.104
9.6000	-0.104
9.8000	-0.107
10.0000	-0.107
12.0000	-0.104
14.0000	-0.104
16.0000	-0.104
18.0000	-0.104
20.0000	-0.101



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 009160 ft/min	by Ecology & Environment	Well: E3-P26-M01
TRANSMISSIVITY 1206 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 2 820 ft	AQUIFER Endless	SUDBURY
Data Set P26M1S1 Date 9-24-93	THICKNESS 13 17	
	SCREEN top 8 000 base 18 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 8 630 TD 21 80	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M02X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	11:55	Date	09/24 /93
Logger Test	1	INPUT 1 Level (F)	

Step 1 09/24 08:51:39

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-2.892	0.3250	-1.438
0.0083	-2.838	0.3333	-1.415
0.0166	-2.790	0.3500	-1.365
0.0250	-2.726	0.3666	-1.317
0.0333	-2.682	0.3833	-1.273
0.0416	-2.638	0.4000	-1.228
0.0500	-2.590	0.4166	-1.184
0.0583	-2.539	0.4333	-1.142
0.0666	-2.492	0.4500	-1.104
0.0750	-2.447	0.4666	-1.066
0.0833	-2.400	0.4833	-1.028
0.0916	-2.434	0.5000	-0.990
0.1000	-2.365	0.5166	-0.955
0.1083	-2.295	0.5333	-0.923
0.1166	-2.250	0.5500	-0.888
0.1250	-2.209	0.5666	-0.860
0.1333	-2.174	0.5833	-0.825
0.1416	-2.133	0.6000	-0.796
0.1500	-2.098	0.6166	-0.768
0.1583	-2.060	0.6333	-0.742
0.1666	-2.025	0.6500	-0.714
0.1750	-1.990	0.6666	-0.685
0.1833	-1.958	0.6833	-0.663
0.1916	-1.917	0.7000	-0.638
0.2000	-1.882	0.7166	-0.612
0.2083	-1.838	0.7333	-0.590
0.2166	-1.809	0.7500	-0.568
0.2250	-1.777	0.7666	-0.546
0.2333	-1.746	0.7833	-0.527
0.2416	-1.717	0.8000	-0.507
0.2500	-1.685	0.8166	-0.485
0.2583	-1.657	0.8333	-0.466
0.2666	-1.628	0.8500	-0.450
0.2750	-1.600	0.8666	-0.431
0.2833	-1.574	0.8833	-0.415
0.2916	-1.546	0.9000	-0.396
0.3000	-1.520	0.9166	-0.380
0.3083	-1.492	0.9333	-0.365
0.3166	-1.463	0.9500	-0.352

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M02X

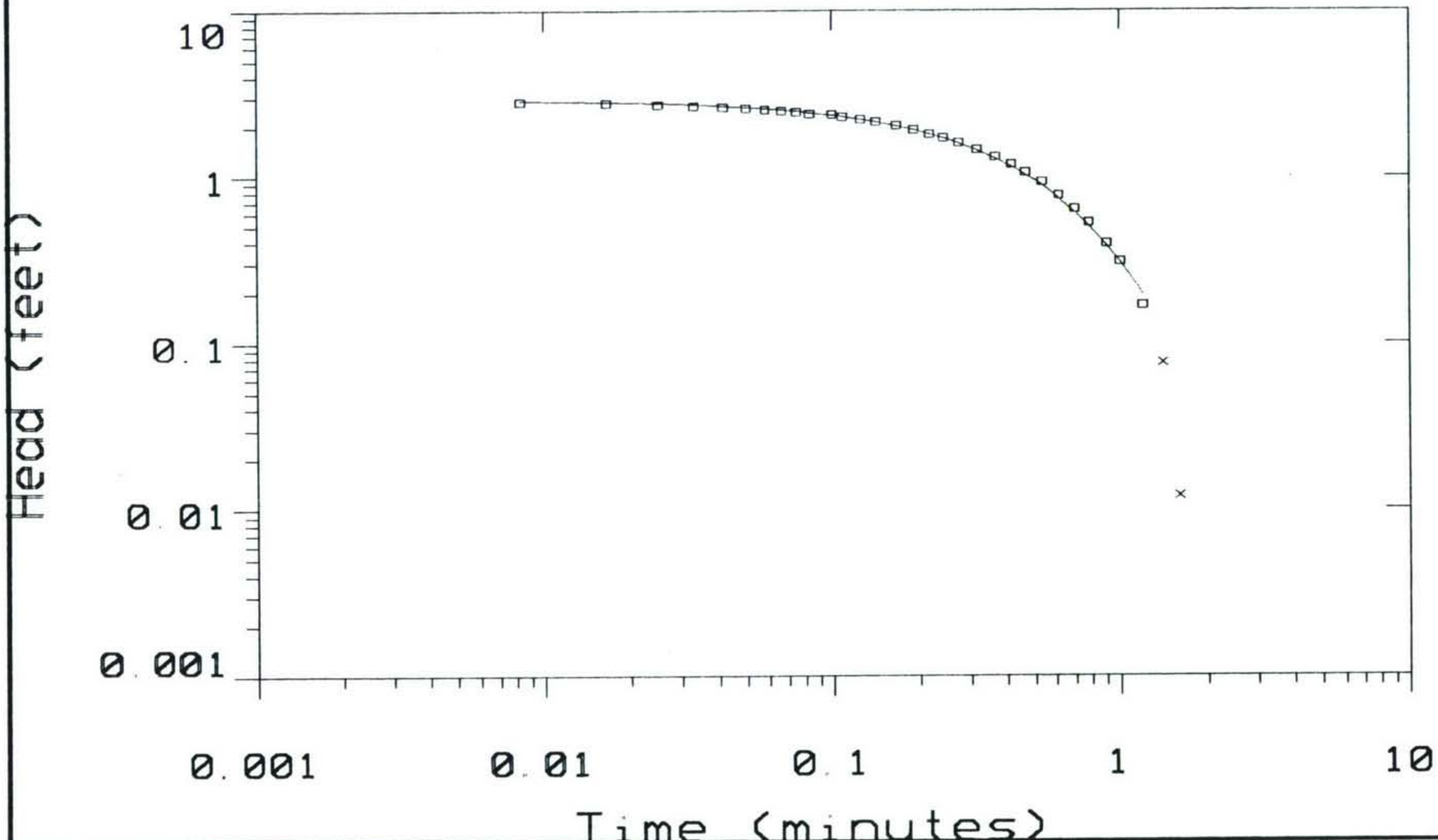
Reference	0.000
SG	1.000
Linearity	0.004
Time	11:55
Logger Test	1

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/24 /93
INPUT 1 Level (F)	

Step 1 09/24 08:51:39

Elapsed Time	INPUT 1
0.9666	-0.336
0.9833	-0.323
1.0000	-0.307
1.2000	-0.168
1.4000	-0.076
1.6000	-0.012
1.8000	0.028
2.0000	0.060
2.2000	0.082
2.4000	0.101
2.6000	0.114
2.8000	0.117
3.0000	0.123
3.2000	0.126
3.4000	0.130
3.6000	0.130
3.8000	0.133
4.0000	0.133
4.2000	0.130
4.4000	0.133
4.6000	0.133
4.8000	0.133
5.0000	0.133
5.2000	0.133
5.4000	0.130
5.6000	0.133
5.8000	0.136
6.0000	0.133
6.2000	0.133
6.4000	0.133
6.6000	0.133
6.8000	0.133
7.0000	0.130
7.2000	0.130
7.4000	0.133
7.6000	0.133
7.8000	0.133
8.0000	0.126
8.2000	0.133

Elapsed Time	INPUT 1
8.4000	0.133
8.6000	0.130
8.8000	0.133
9.0000	0.133
9.2000	0.130
9.4000	0.130
9.6000	0.133
9.8000	0.133
10.0000	0.130
12.0000	0.133
14.0000	0.133
16.0000	0.130
18.0000	0.130



MODEL TYPE: BOUWER and RICE	
CONDUCTIVITY: .009423 ft/min	
TRANSMISSIVITY: .1179 sq. ft/min	
INITIAL HEAD: 2.838 ft	
Data Set: P26M2S1	Date: 9-24-93

for: USAEC
by: Ecology & Environment
WELL DATA Units: ft
AQUIFER: Endless
THICKNESS: 12.52
SCREEN: top: 9.000 base: 19.00
DIAMETER: casing: .3400 intake: .3400
DEPTH: Water Table: 8.050 TD: 20.57

Well Slug Test Data
Well: E3-P26-M02
SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M03X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:13	Date	09/23 /93
Logger Test	6	INPUT 1 Level (F)	

Step 1 09/23 17:08:13

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-3.231	0.3250	-2.901
0.0083	-3.215	0.3333	-2.910
0.0166	-3.203	0.3500	-2.923
0.0250	-3.196	0.3666	-2.888
0.0333	-3.187	0.3833	-2.863
0.0416	-3.177	0.4000	-2.850
0.0500	-3.168	0.4166	-2.841
0.0583	-3.149	0.4333	-2.837
0.0666	-3.130	0.4500	-2.825
0.0750	-3.117	0.4666	-2.812
0.0833	-3.117	0.4833	-2.818
0.0916	-3.104	0.5000	-2.771
0.1000	-3.091	0.5166	-2.758
0.1083	-3.088	0.5333	-2.707
0.1166	-3.079	0.5500	-2.701
0.1250	-3.066	0.5666	-2.688
0.1333	-3.060	0.5833	-2.676
0.1416	-3.053	0.6000	-2.660
0.1500	-3.041	0.6166	-2.647
0.1583	-3.034	0.6333	-2.634
0.1666	-3.031	0.6500	-2.622
0.1750	-3.053	0.6666	-2.609
0.1833	-3.031	0.6833	-2.596
0.1916	-3.031	0.7000	-2.584
0.2000	-3.028	0.7166	-2.571
0.2083	-3.009	0.7333	-2.558
0.2166	-2.977	0.7500	-2.545
0.2250	-2.958	0.7666	-2.533
0.2333	-2.945	0.7833	-2.523
0.2416	-2.939	0.8000	-2.511
0.2500	-2.933	0.8166	-2.498
0.2583	-2.958	0.8333	-2.485
0.2666	-2.964	0.8500	-2.476
0.2750	-2.920	0.8666	-2.463
0.2833	-2.910	0.8833	-2.450
0.2916	-2.917	0.9000	-2.441
0.3000	-2.917	0.9166	-2.428
0.3083	-2.910	0.9333	-2.415
0.3166	-2.904	0.9500	-2.406

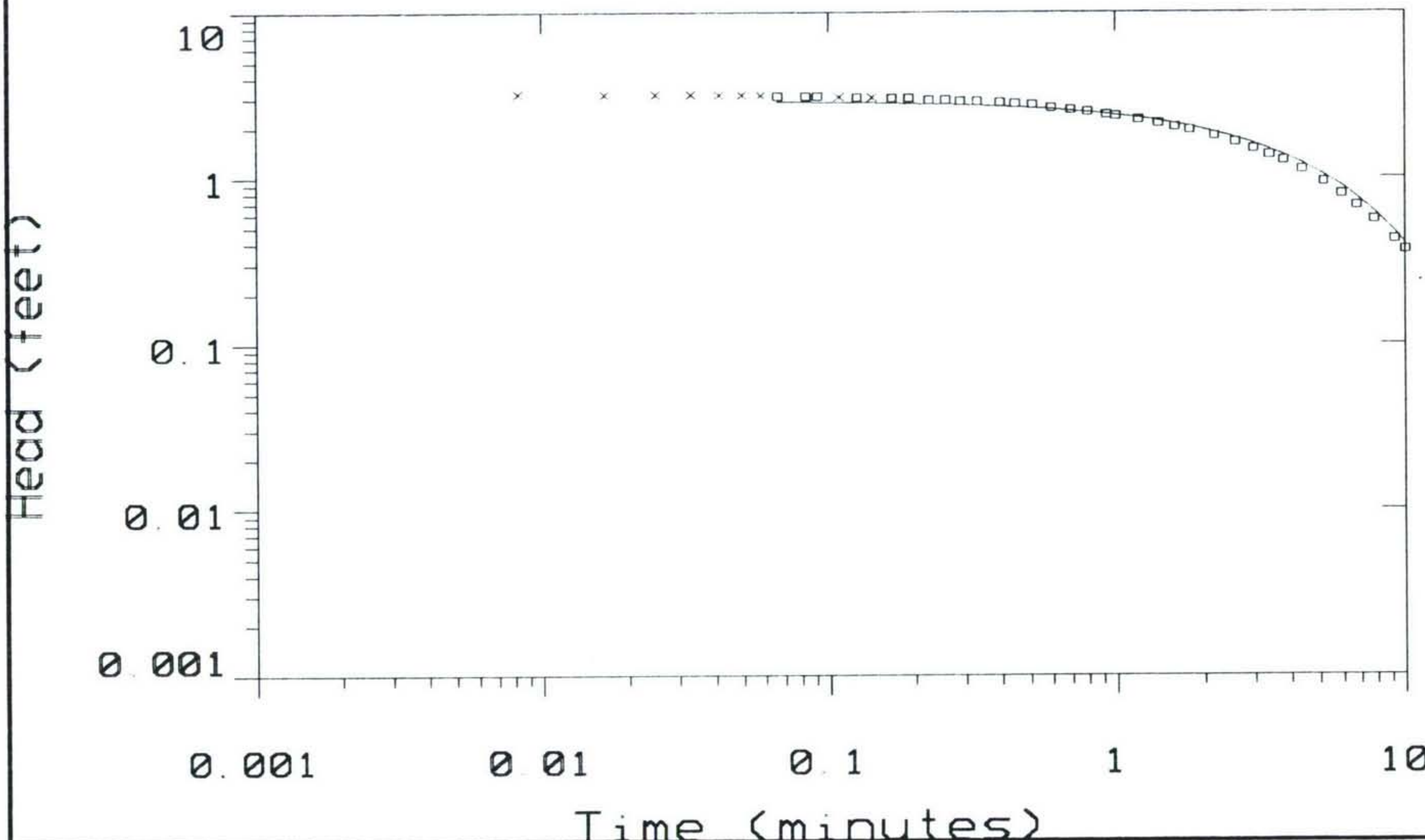
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P26-M03X

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	19:13		Date	09/23 /93
Logger Test	6		INPUT 1 Level (F)	

Step 1 09/23 17:08:13

Elapsed Time	INPUT 1
0.9666	-2.393
0.9833	-2.384
1.0000	-2.371
1.2000	-2.247
1.4000	-2.133
1.6000	-2.041
1.8000	-1.952
2.0000	-1.866
2.2000	-1.787
2.4000	-1.711
2.6000	-1.638
2.8000	-1.568
3.0000	-1.501
3.2000	-1.438
3.4000	-1.377
3.6000	-1.320
3.8000	-1.266
4.0000	-1.212
4.2000	-1.161
4.4000	-1.114
4.6000	-1.069
4.8000	-1.025
5.0000	-0.980
5.2000	-0.942
5.4000	-0.904
5.6000	-0.866
5.8000	-0.831
6.0000	-0.796
6.2000	-0.765
6.4000	-0.736
6.6000	-0.707
6.8000	-0.676
7.0000	-0.650
7.2000	-0.625
7.4000	-0.600
7.6000	-0.577
7.8000	-0.555
8.0000	-0.533
8.2000	-0.514

Elapsed Time	INPUT 1
8.4000	-0.492
8.6000	-0.473
8.8000	-0.457
9.0000	-0.438
9.2000	-0.422
9.4000	-0.409
9.6000	-0.393
9.8000	-0.377
10.0000	-0.365
12.0000	-0.257
14.0000	-0.184
16.0000	-0.136
18.0000	-0.104
20.0000	-0.082
22.0000	-0.066
24.0000	-0.060
26.0000	-0.053
28.0000	-0.047
30.0000	-0.044
32.0000	-0.041
34.0000	-0.041
36.0000	-0.038
38.0000	-0.038



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY .0008642 ft/min	by Ecology & Environment	Well: E3-P26-M03
TRANSMISSIVITY .01013 sq. ft/min	WELL DATA Units: ft	SUDBURY, MA
INITIAL HEAD 3.215 ft	AQUIFER Endless	SUDBURY
Data Set P26M3S1	THICKNESS 11.73	
Date 9-23-93	SCREEN top 9.000 base 19.00	
	DIAMETER casing .3400 intake .3400	
	DEPTH Water Table 8.480 TD 20.21	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P31-M01X

Reference	0.000		Scale Factor	10.012
SG	1.000		Offset	-0.042
Linearity	0.009		Delay mSEC	50.000
Time	21:35		Date	09/21 /93
Logger Test	1		INPUT 3 Level (F)	

Step 1 09/21 09:49:08

Elapsed Time	INPUT 3	Elapsed Time	INPUT 3
0.0000	-1.764	0.3250	-1.138
0.0083	-1.742	0.3333	-1.126
0.0166	-1.723	0.3500	-1.097
0.0250	-1.707	0.3666	-1.072
0.0333	-1.688	0.3833	-1.046
0.0416	-1.673	0.4000	-1.021
0.0500	-1.651	0.4166	-0.996
0.0583	-1.635	0.4333	-0.974
0.0666	-1.616	0.4500	-0.952
0.0750	-1.600	0.4666	-0.929
0.0833	-1.581	0.4833	-0.907
0.0916	-1.565	0.5000	-0.882
0.1000	-1.546	0.5166	-0.863
0.1083	-1.530	0.5333	-0.844
0.1166	-1.515	0.5500	-0.825
0.1250	-1.499	0.5666	-0.806
0.1333	-1.483	0.5833	-0.787
0.1416	-1.467	0.6000	-0.768
0.1500	-1.448	0.6166	-0.752
0.1583	-1.432	0.6333	-0.736
0.1666	-1.416	0.6500	-0.718
0.1750	-1.401	0.6666	-0.702
0.1833	-1.388	0.6833	-0.686
0.1916	-1.372	0.7000	-0.670
0.2000	-1.356	0.7166	-0.657
0.2083	-1.341	0.7333	-0.642
0.2166	-1.325	0.7500	-0.629
0.2250	-1.312	0.7666	-0.613
0.2333	-1.296	0.7833	-0.600
0.2416	-1.280	0.8000	-0.591
0.2500	-1.268	0.8166	-0.575
0.2583	-1.252	0.8333	-0.563
0.2666	-1.236	0.8500	-0.553
0.2750	-1.224	0.8666	-0.540
0.2833	-1.208	0.8833	-0.531
0.2916	-1.195	0.9000	-0.521
0.3000	-1.179	0.9166	-0.512
0.3083	-1.167	0.9333	-0.502
0.3166	-1.154	0.9500	-0.493

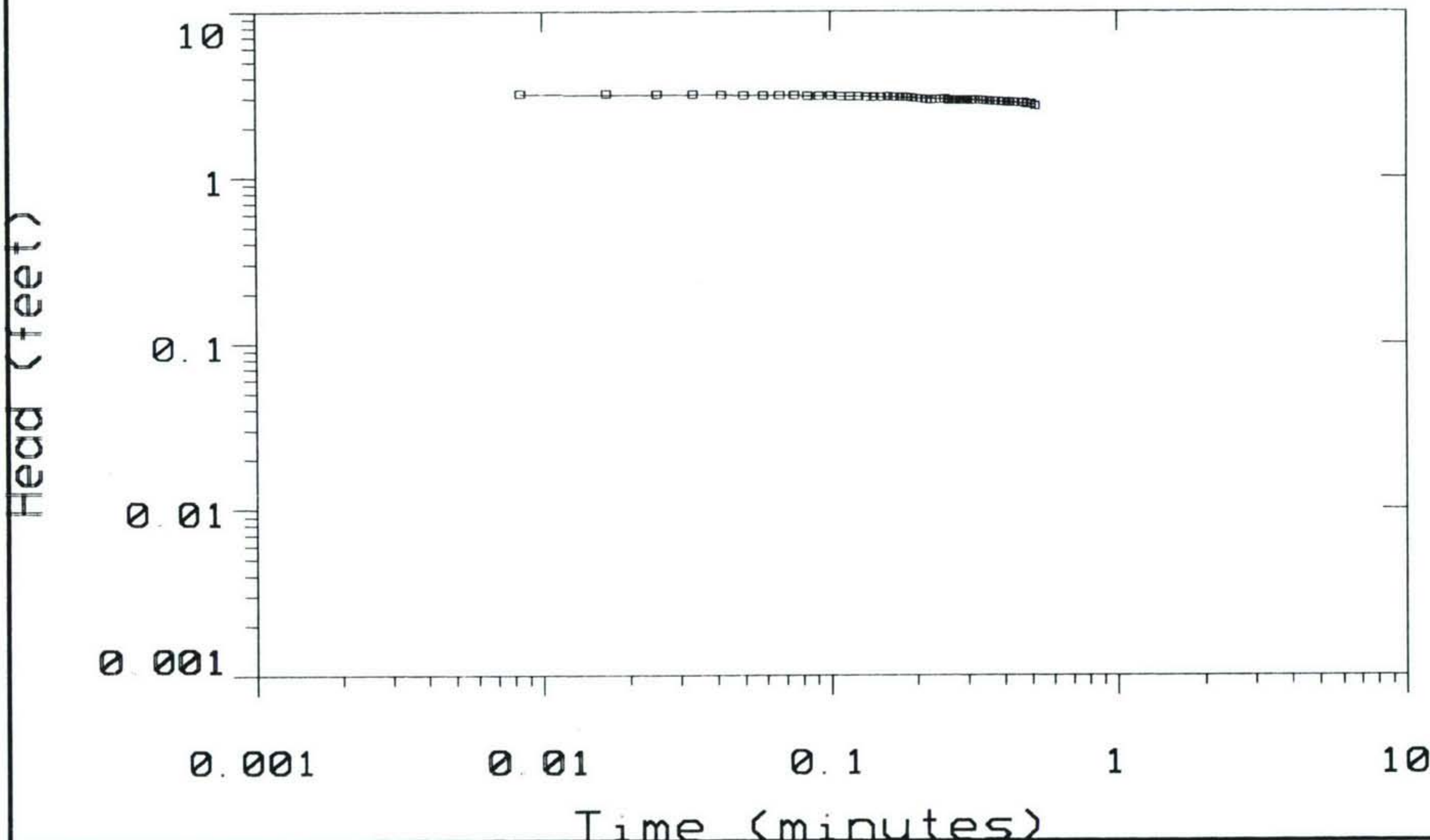
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P31-M01X

Reference	0.000	Scale Factor	10.012
SG	1.000	Offset	-0.042
Linearity	0.009	Delay mSEC	50.000
Time	21:35	Date	09/21 /93
Logger Test	1	INPUT 3 Level (F)	

Step 1 09/21 09:49:08

Elapsed Time	INPUT 3
0.9666	-0.483
0.9833	-0.474
1.0000	-0.464
1.2000	-0.385
1.4000	-0.335
1.6000	-0.309
1.8000	-0.294
2.0000	-0.284
2.2000	-0.275
2.4000	-0.268
2.6000	-0.265
2.8000	-0.259
3.0000	-0.256
3.2000	-0.249
3.4000	-0.246
3.6000	-0.243
3.8000	-0.240
4.0000	-0.237
4.2000	-0.234
4.4000	-0.234
4.6000	-0.230
4.8000	-0.227
5.0000	-0.227
5.2000	-0.224
5.4000	-0.221
5.6000	-0.221
5.8000	-0.218
6.0000	-0.215
6.2000	-0.215
6.4000	-0.211
6.6000	-0.208
6.8000	-0.208
7.0000	-0.208
7.2000	-0.205
7.4000	-0.205
7.6000	-0.202
7.8000	-0.202
8.0000	-0.199
8.2000	-0.199

Elapsed Time	INPUT 3
8.4000	-0.196
8.6000	-0.196
8.8000	-0.192
9.0000	-0.192
9.2000	-0.189
9.4000	-0.189
9.6000	-0.189
9.8000	-0.186
10.0000	-0.186
12.0000	-0.170
14.0000	-0.161
16.0000	-0.145
18.0000	-0.139
20.0000	-0.126
22.0000	-0.117
24.0000	-0.107
26.0000	-0.101
28.0000	-0.094
30.0000	-0.085
32.0000	-0.079
34.0000	-0.072



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY 001195 ft/min	
TRANSMISSIVITY 01279 sq ft/min	
INITIAL HEAD 3 196 ft	
Data Set P31S1	Date 9-21-93

for USAEC
by Ecology & Environment
WELL DATA Units ft
AQUIFER Endless
THICKNESS 10 71
SCREEN top 8 000 base 18 00
DIAMETER casing 3400 intake 3400
DEPTH Water Table 9 380 TD 20 09

Well Slug Test Data

Well: E3-P31-M01

SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:12	Date	09/21 /93
Logger Test	4	INPUT 1 Level (F)	

Step 1 09/21 14:46:43

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-0.802	0.3250	-0.304
0.0083	-0.717	0.3333	-0.301
0.0166	-0.650	0.3500	-0.301
0.0250	-0.590	0.3666	-0.298
0.0333	-0.539	0.3833	-0.295
0.0416	-0.507	0.4000	-0.291
0.0500	-0.479	0.4166	-0.291
0.0583	-0.453	0.4333	-0.288
0.0666	-0.431	0.4500	-0.285
0.0750	-0.418	0.4666	-0.285
0.0833	-0.399	0.4833	-0.282
0.0916	-0.393	0.5000	-0.282
0.1000	-0.387	0.5166	-0.279
0.1083	-0.377	0.5333	-0.279
0.1166	-0.374	0.5500	-0.276
0.1250	-0.371	0.5666	-0.276
0.1333	-0.364	0.5833	-0.272
0.1416	-0.358	0.6000	-0.272
0.1500	-0.355	0.6166	-0.269
0.1583	-0.349	0.6333	-0.269
0.1666	-0.345	0.6500	-0.269
0.1750	-0.342	0.6666	-0.266
0.1833	-0.339	0.6833	-0.266
0.1916	-0.336	0.7000	-0.263
0.2000	-0.333	0.7166	-0.263
0.2083	-0.330	0.7333	-0.263
0.2166	-0.326	0.7500	-0.260
0.2250	-0.326	0.7666	-0.260
0.2333	-0.323	0.7833	-0.260
0.2416	-0.320	0.8000	-0.260
0.2500	-0.320	0.8166	-0.257
0.2583	-0.317	0.8333	-0.257
0.2666	-0.314	0.8500	-0.253
0.2750	-0.314	0.8666	-0.253
0.2833	-0.311	0.8833	-0.253
0.2916	-0.311	0.9000	-0.250
0.3000	-0.307	0.9166	-0.250
0.3083	-0.307	0.9333	-0.250
0.3166	-0.304	0.9500	-0.247

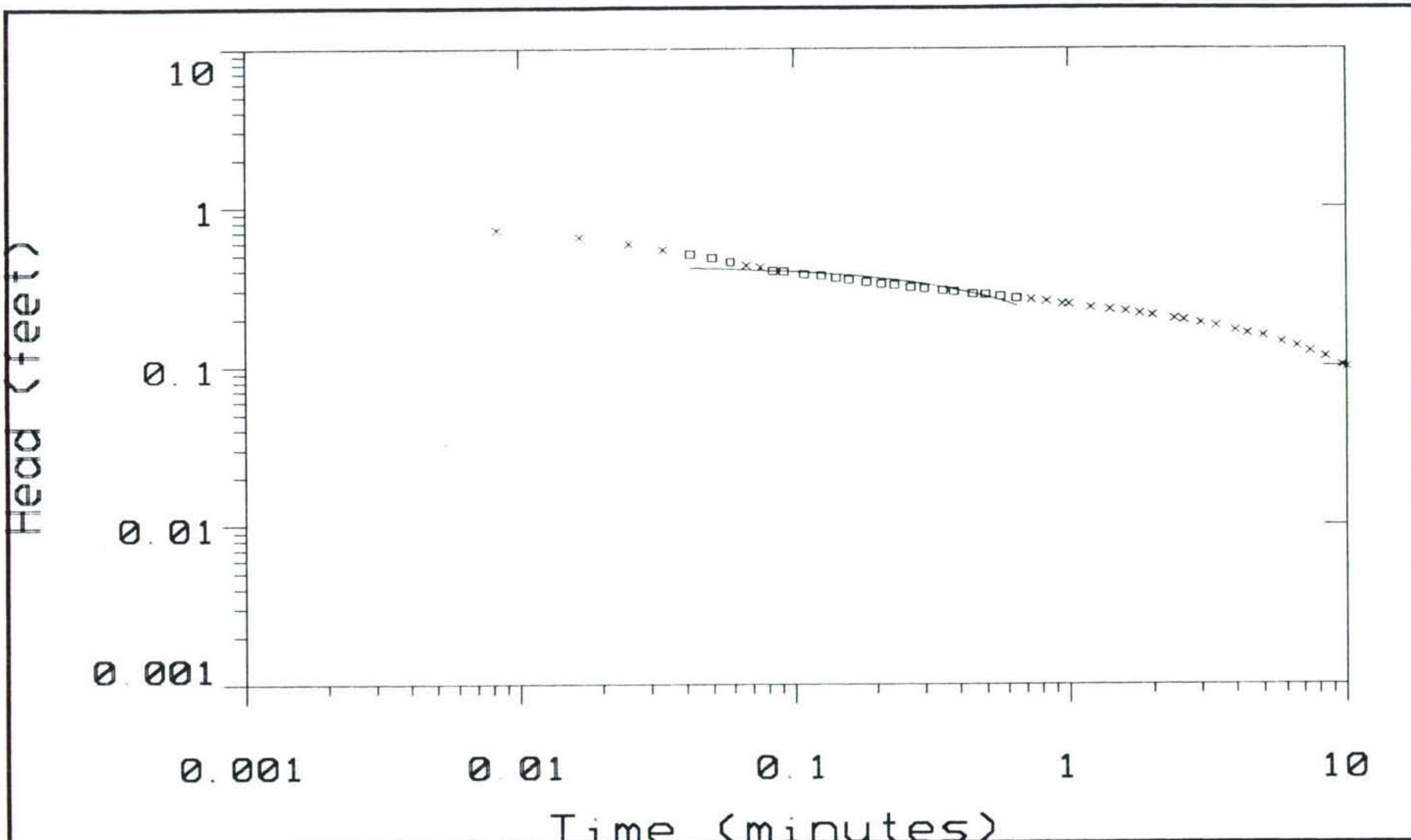
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	20:12	Date	09/21 /93
Logger Test	4	INPUT 1 Level (F)	

Step 1 09/21 14:46:43

Elapsed Time	INPUT 1
0.9666	-0.247
0.9833	-0.247
1.0000	-0.247
1.2000	-0.234
1.4000	-0.228
1.6000	-0.222
1.8000	-0.215
2.0000	-0.209
2.2000	-0.206
2.4000	-0.199
2.6000	-0.196
2.8000	-0.190
3.0000	-0.187
3.2000	-0.184
3.4000	-0.180
3.6000	-0.174
3.8000	-0.171
4.0000	-0.168
4.2000	-0.165
4.4000	-0.161
4.6000	-0.158
4.8000	-0.155
5.0000	-0.155
5.2000	-0.149
5.4000	-0.149
5.6000	-0.145
5.8000	-0.142
6.0000	-0.139
6.2000	-0.136
6.4000	-0.133
6.6000	-0.133
6.8000	-0.130
7.0000	-0.126
7.2000	-0.126
7.4000	-0.123
7.6000	-0.120
7.8000	-0.120
8.0000	-0.117
8.2000	-0.114

Elapsed Time	INPUT 1
8.4000	-0.114
8.6000	-0.111
8.8000	-0.111
9.0000	-0.107
9.2000	-0.104
9.4000	-0.104
9.6000	-0.101
9.8000	-0.101
10.0000	-0.098
12.0000	-0.085
14.0000	-0.072
16.0000	-0.060



MODEL TYPE: BOUWER and RICE	
CONDUCTIVITY: .003472 ft/min	
TRANSMISSIVITY: .008646 sq. ft/min	
INITIAL HEAD: .7170 ft	
Data Set: P36M1S1	Date: 9-21-93

for USAEC
by Ecology & Environment

WELL DATA Units: ft
AQUIFER: Endless
THICKNESS: 2.490
SCREEN: top 8.000 base 18.00
DIAMETER: casing .3400 intake .3400
DEPTH: Water Table 17.01 TD 19.50

Well Slug Test Data

Well: E3-P36-M01

SUDBURY, MA
SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M02X

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	20:21		Date	09/21 /93
Logger Test	3		INPUT 1 Level (F)	

Step 1 09/21 13:42:03

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-0.180	0.3250	-0.104
0.0083	-0.165	0.3333	-0.104
0.0166	-0.149	0.3500	-0.104
0.0250	-0.142	0.3666	-0.101
0.0333	-0.136	0.3833	-0.101
0.0416	-0.133	0.4000	-0.104
0.0500	-0.130	0.4166	-0.101
0.0583	-0.126	0.4333	-0.101
0.0666	-0.123	0.4500	-0.101
0.0750	-0.123	0.4666	-0.101
0.0833	-0.120	0.4833	-0.101
0.0916	-0.114	0.5000	-0.101
0.1000	-0.120	0.5166	-0.101
0.1083	-0.114	0.5333	-0.101
0.1166	-0.117	0.5500	-0.101
0.1250	-0.114	0.5666	-0.101
0.1333	-0.114	0.5833	-0.098
0.1416	-0.114	0.6000	-0.098
0.1500	-0.114	0.6166	-0.098
0.1583	-0.111	0.6333	-0.098
0.1666	-0.111	0.6500	-0.098
0.1750	-0.111	0.6666	-0.098
0.1833	-0.111	0.6833	-0.098
0.1916	-0.111	0.7000	-0.098
0.2000	-0.107	0.7166	-0.098
0.2083	-0.107	0.7333	-0.098
0.2166	-0.107	0.7500	-0.098
0.2250	-0.107	0.7666	-0.098
0.2333	-0.107	0.7833	-0.098
0.2416	-0.107	0.8000	-0.095
0.2500	-0.107	0.8166	-0.095
0.2583	-0.104	0.8333	-0.095
0.2666	-0.104	0.8500	-0.095
0.2750	-0.107	0.8666	-0.095
0.2833	-0.104	0.8833	-0.095
0.2916	-0.104	0.9000	-0.095
0.3000	-0.104	0.9166	-0.095
0.3083	-0.104	0.9333	-0.095
0.3166	-0.104	0.9500	-0.095

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M02X

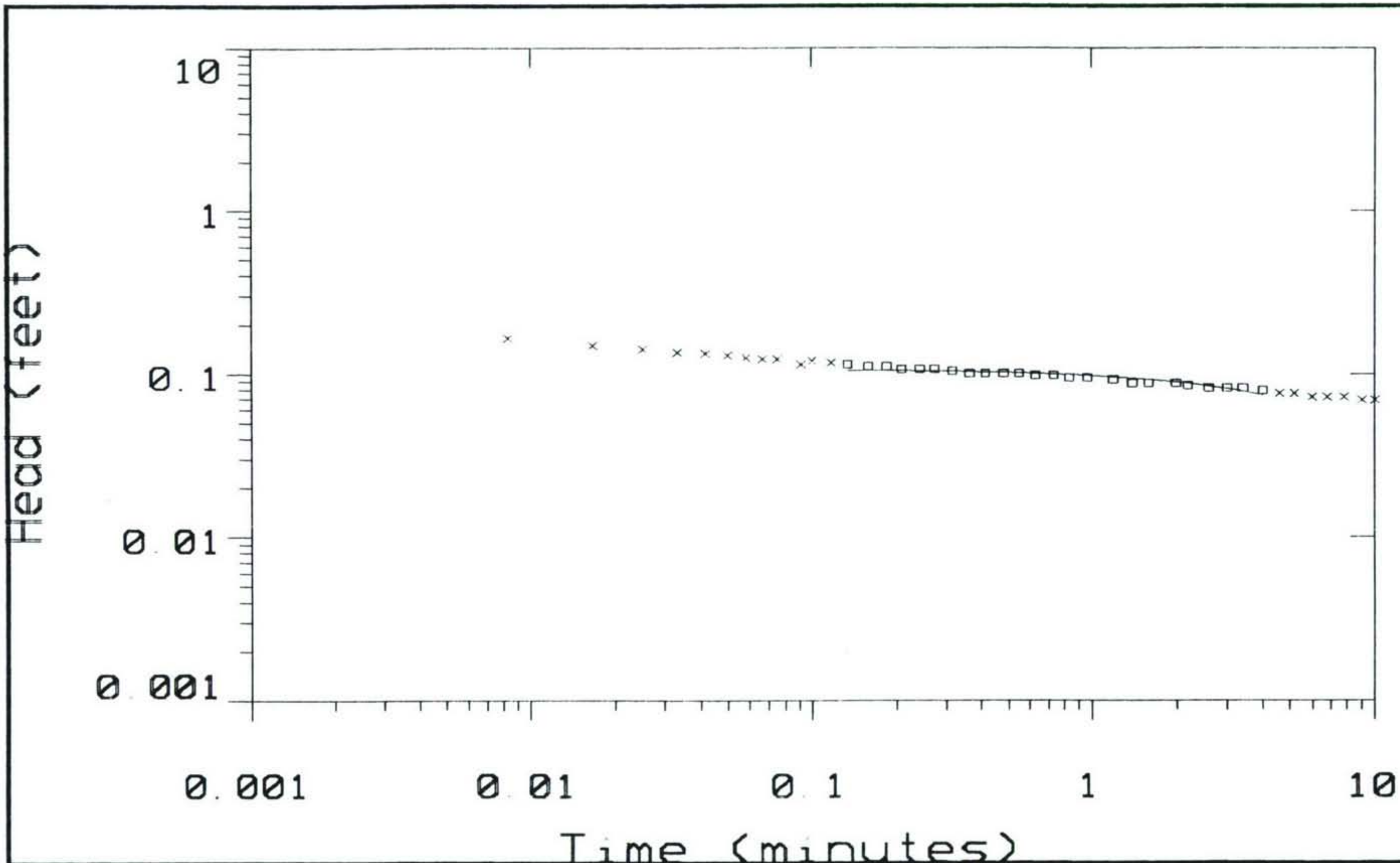
Reference	0.000
SG	1.000
Linearity	0.004
Time	20:21
Logger Test	3

Scale Factor	10.051
Offset	-0.010
Delay mSEC	50.000
Date	09/21 /93
INPUT 1 Level (F)	

Step 1 09/21 13:42:03

Elapsed Time	INPUT 1
0.9666	-0.095
0.9833	-0.095
1.0000	-0.095
1.2000	-0.092
1.4000	-0.088
1.6000	-0.088
1.8000	-0.088
2.0000	-0.088
2.2000	-0.085
2.4000	-0.082
2.6000	-0.082
2.8000	-0.082
3.0000	-0.082
3.2000	-0.082
3.4000	-0.082
3.6000	-0.082
3.8000	-0.079
4.0000	-0.079
4.2000	-0.079
4.4000	-0.079
4.6000	-0.076
4.8000	-0.076
5.0000	-0.076
5.2000	-0.076
5.4000	-0.076
5.6000	-0.076
5.8000	-0.076
6.0000	-0.072
6.2000	-0.072
6.4000	-0.076
6.6000	-0.072
6.8000	-0.072
7.0000	-0.072
7.2000	-0.072
7.4000	-0.072
7.6000	-0.072
7.8000	-0.072
8.0000	-0.072
8.2000	-0.072

Elapsed Time	INPUT 1
8.4000	-0.072
8.6000	-0.072
8.8000	-0.069
9.0000	-0.069
9.2000	-0.069
9.4000	-0.069
9.6000	-0.069
9.8000	-0.069
10.0000	-0.069
12.0000	-0.066
14.0000	-0.063
16.0000	-0.060
18.0000	-0.060
20.0000	-0.057
22.0000	-0.053
24.0000	-0.050
26.0000	-0.047
28.0000	-0.050
30.0000	-0.047
32.0000	-0.044



MODEL TYPE. BOUWER and RICE

CONDUCTIVITY 0005793 ft/min

TRANSMISSIVITY 003012 sq ft/min

INITIAL HEAD 1650 ft

Data Set F36M2S1 | Date 9-21-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 5 200

SCREEN top 8 000 base 18 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 15 60 TD 20 80

Well Slug Test Data

Well: E3-P36-M02

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M03X

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	20:26	Date	09/21 /93
Logger Test	3	INPUT 2 Level (F)	

Step 1 09/21 13:42:03

Elapsed Time	INPUT 2
0.0000	-1.207
0.0083	-1.160
0.0166	-1.110
0.0250	-1.059
0.0333	-1.002
0.0416	-0.965
0.0500	-0.930
0.0583	-0.889
0.0666	-0.857
0.0750	-0.823
0.0833	-0.797
0.0916	-0.766
0.1000	-0.747
0.1083	-0.722
0.1166	-0.706
0.1250	-0.690
0.1333	-0.678
0.1416	-0.665
0.1500	-0.656
0.1583	-0.649
0.1666	-0.640
0.1750	-0.633
0.1833	-0.630
0.1916	-0.624
0.2000	-0.621
0.2083	-0.615
0.2166	-0.611
0.2250	-0.608
0.2333	-0.605
0.2416	-0.599
0.2500	-0.592
0.2583	-0.589
0.2666	-0.586
0.2750	-0.583
0.2833	-0.580
0.2916	-0.580
0.3000	-0.577
0.3083	-0.574
0.3166	-0.570

Elapsed Time	INPUT 2
0.3250	-0.570
0.3333	-0.567
0.3500	-0.564
0.3666	-0.561
0.3833	-0.558
0.4000	-0.555
0.4166	-0.551
0.4333	-0.548
0.4500	-0.545
0.4666	-0.542
0.4833	-0.539
0.5000	-0.536
0.5166	-0.533
0.5333	-0.529
0.5500	-0.529
0.5666	-0.526
0.5833	-0.523
0.6000	-0.520
0.6166	-0.517
0.6333	-0.514
0.6500	-0.514
0.6666	-0.510
0.6833	-0.507
0.7000	-0.504
0.7166	-0.504
0.7333	-0.501
0.7500	-0.498
0.7666	-0.495
0.7833	-0.495
0.8000	-0.492
0.8166	-0.488
0.8333	-0.485
0.8500	-0.485
0.8666	-0.482
0.8833	-0.479
0.9000	-0.479
0.9166	-0.476
0.9333	-0.473
0.9500	-0.473

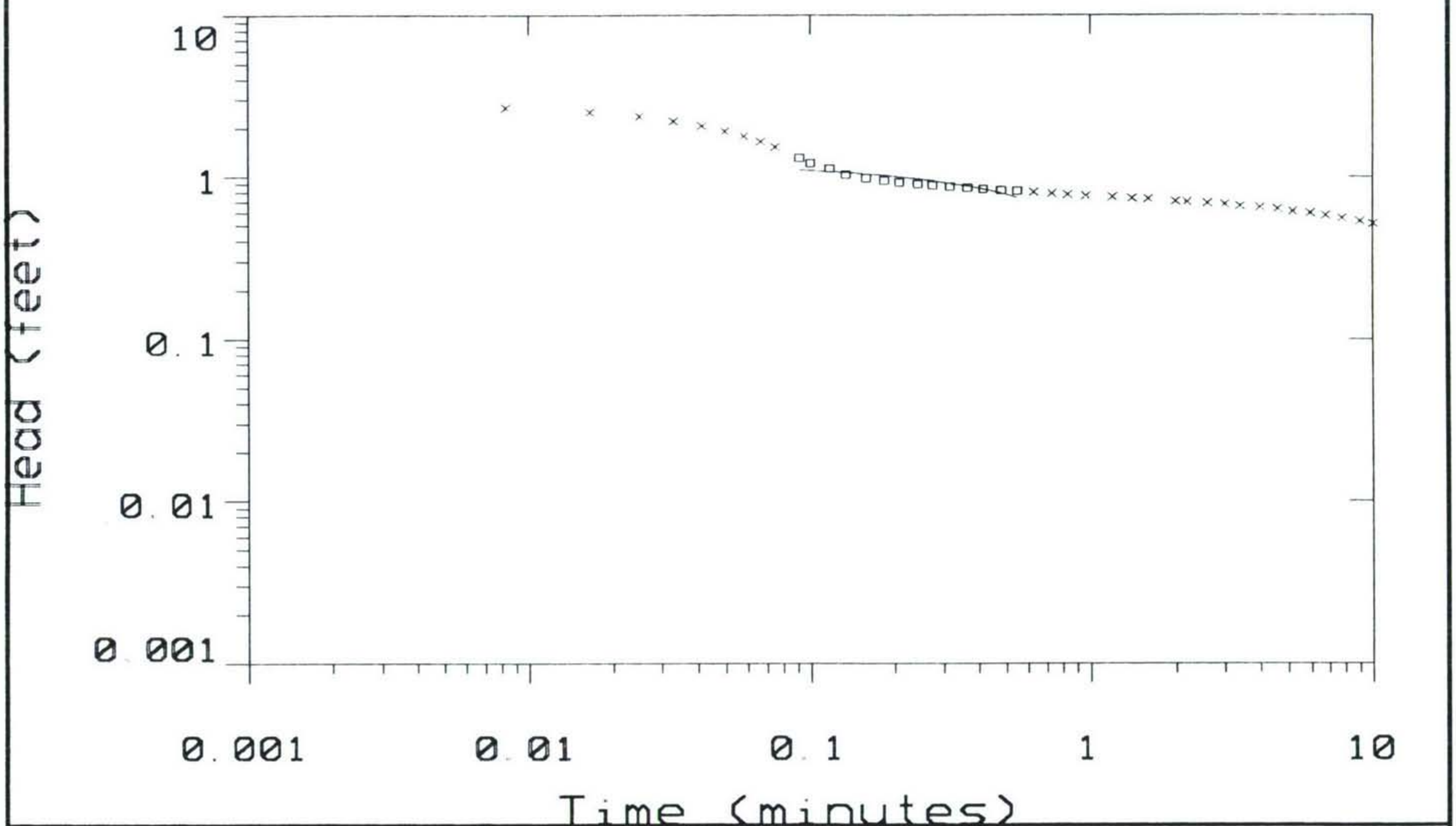
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P36-M03X

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	20:26	Date	09/21 /93
Logger Test	3	INPUT 2 Level (F)	

Step 1 09/21 13:42:03

Elapsed Time	INPUT 2
0.9666	-0.469
0.9833	-0.466
1.0000	-0.466
1.2000	-0.441
1.4000	-0.422
1.6000	-0.403
1.8000	-0.384
2.0000	-0.365
2.2000	-0.350
2.4000	-0.334
2.6000	-0.318
2.8000	-0.305
3.0000	-0.290
3.2000	-0.277
3.4000	-0.264
3.6000	-0.252
3.8000	-0.239
4.0000	-0.227
4.2000	-0.214
4.4000	-0.201
4.6000	-0.189
4.8000	-0.176
5.0000	-0.164
5.2000	-0.148
5.4000	-0.126
5.6000	-0.110
5.8000	-0.094
6.0000	-0.078
6.2000	-0.069
6.4000	-0.056
6.6000	-0.050
6.8000	-0.044
7.0000	-0.037
7.2000	-0.031
7.4000	-0.028
7.6000	-0.025
7.8000	-0.022
8.0000	-0.022
8.2000	-0.018

Elapsed Time	INPUT 2
8.4000	-0.015
8.6000	-0.015
8.8000	-0.015
9.0000	-0.015
9.2000	-0.012
9.4000	-0.012
9.6000	-0.012
9.8000	-0.012
10.0000	-0.009
12.0000	-0.006
14.0000	-0.006
16.0000	-0.003
18.0000	-0.003
20.0000	-0.003
22.0000	0.000
24.0000	0.000
26.0000	0.000
28.0000	-0.003
30.0000	-0.003
32.0000	-0.003



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 006670 ft/min	by Ecology & Environment	Well: E3-P36-M03
TRANSMISSIVITY 03001 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 2 681 ft	AQUIFER Endless	SUDBURY
Data Set F36M3S1	THICKNESS 4 500	
Date 9-21-93	SCREEN top 9 000 base 19 00	
	DIAMETER casing 3400 intake 3400	
	DEPTH Water Table 16 68 TD 21 18	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M01X

Reference	0.000	Scale Factor	10.012
SG	1.000	Offset	-0.042
Linearity	0.009	Delay mSEC	50.000
Time	20:30	Date	09/21 /93
Logger Test	3	INPUT 3 Level (F)	

Step 1 09/21 13:42:03

Elapsed Time	INPUT 3	Elapsed Time	INPUT 3
0.0000	2.830	0.3250	0.869
0.0083	2.681	0.3333	0.866
0.0166	2.514	0.3500	0.863
0.0250	2.365	0.3666	0.857
0.0333	2.223	0.3833	0.853
0.0416	2.065	0.4000	0.847
0.0500	1.919	0.4166	0.844
0.0583	1.783	0.4333	0.841
0.0666	1.653	0.4500	0.838
0.0750	1.533	0.4666	0.834
0.0833	1.413	0.4833	0.831
0.0916	1.315	0.5000	0.825
0.1000	1.223	0.5166	0.822
0.1083	1.170	0.5333	0.822
0.1166	1.125	0.5500	0.819
0.1250	1.072	0.5666	0.815
0.1333	1.037	0.5833	0.812
0.1416	1.015	0.6000	0.809
0.1500	0.996	0.6166	0.809
0.1583	0.980	0.6333	0.806
0.1666	0.967	0.6500	0.803
0.1750	0.958	0.6666	0.803
0.1833	0.948	0.6833	0.800
0.1916	0.942	0.7000	0.796
0.2000	0.936	0.7166	0.796
0.2083	0.929	0.7333	0.793
0.2166	0.923	0.7500	0.793
0.2250	0.917	0.7666	0.790
0.2333	0.913	0.7833	0.790
0.2416	0.907	0.8000	0.787
0.2500	0.904	0.8166	0.784
0.2583	0.898	0.8333	0.784
0.2666	0.894	0.8500	0.781
0.2750	0.891	0.8666	0.781
0.2833	0.888	0.8833	0.777
0.2916	0.882	0.9000	0.777
0.3000	0.879	0.9166	0.777
0.3083	0.876	0.9333	0.774
0.3166	0.872	0.9500	0.774

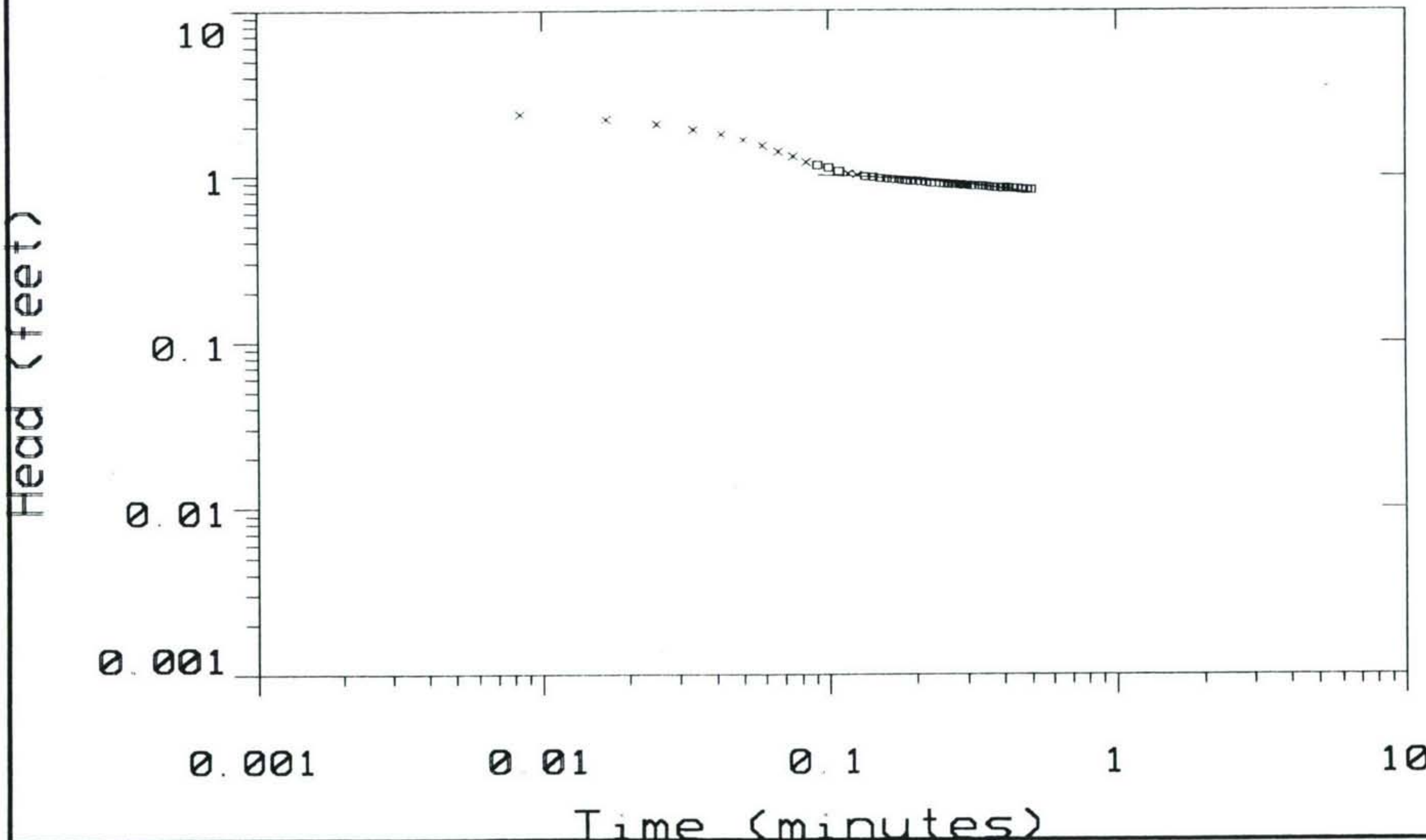
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M01X

Reference	0.000		Scale Factor	10.012
SG	1.000		Offset	-0.042
Linearity	0.009		Delay mSEC	50.000
Time	20:30		Date	09/21 /93
Logger Test	3		INPUT 3 Level (F)	

Step 1 09/21 13:42:03

Elapsed Time	INPUT 3
0.9666	0.771
0.9833	0.771
1.0000	0.771
1.2000	0.755
1.4000	0.743
1.6000	0.733
1.8000	0.724
2.0000	0.714
2.2000	0.708
2.4000	0.702
2.6000	0.695
2.8000	0.686
3.0000	0.679
3.2000	0.673
3.4000	0.667
3.6000	0.660
3.8000	0.657
4.0000	0.651
4.2000	0.645
4.4000	0.638
4.6000	0.635
4.8000	0.629
5.0000	0.623
5.2000	0.616
5.4000	0.613
5.6000	0.607
5.8000	0.604
6.0000	0.597
6.2000	0.594
6.4000	0.588
6.6000	0.585
6.8000	0.578
7.0000	0.575
7.2000	0.569
7.4000	0.566
7.6000	0.562
7.8000	0.556
8.0000	0.553
8.2000	0.550

Elapsed Time	INPUT 3
8.4000	0.543
8.6000	0.540
8.8000	0.537
9.0000	0.534
9.2000	0.528
9.4000	0.524
9.6000	0.521
9.8000	0.518
10.0000	0.515
12.0000	0.483
14.0000	0.452
16.0000	0.426
18.0000	0.398
20.0000	0.376
22.0000	0.351
24.0000	0.328
26.0000	0.309
28.0000	0.290
30.0000	0.271
32.0000	0.253



MODEL TYPE BOUWER and RICE	
CONDUCTIVITY 008096 ft/min	
TRANSMISSIVITY 05821 sq ft/min	
INITIAL HEAD 2 365 ft	
Data Set F37M1S1	Date 9-21-93

for USAEC
by Ecology & Environment
WELL DATA Units ft
AQUIFER Endless
THICKNESS 7 190
SCREEN top 9 500 base 19 50
DIAMETER casing 3400 intake 3400
DEPTH Water Table 13 95 TD 21 14

Well Slug Test Data

Well: E3-P37-M01

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M02X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	21:11	Date	09/21 /93
Logger Test	2	INPUT 1 Level (F)	

Step 1 09/21 11:43:24

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-0.380	0.3250	-0.349
0.0083	-0.371	0.3333	-0.349
0.0166	-0.368	0.3500	-0.345
0.0250	-0.368	0.3666	-0.345
0.0333	-0.371	0.3833	-0.342
0.0416	-0.371	0.4000	-0.339
0.0500	-0.371	0.4166	-0.339
0.0583	-0.384	0.4333	-0.336
0.0666	-0.393	0.4500	-0.336
0.0750	-0.387	0.4666	-0.333
0.0833	-0.377	0.4833	-0.333
0.0916	-0.374	0.5000	-0.330
0.1000	-0.371	0.5166	-0.330
0.1083	-0.371	0.5333	-0.326
0.1166	-0.371	0.5500	-0.326
0.1250	-0.371	0.5666	-0.323
0.1333	-0.371	0.5833	-0.323
0.1416	-0.368	0.6000	-0.320
0.1500	-0.368	0.6166	-0.320
0.1583	-0.368	0.6333	-0.317
0.1666	-0.364	0.6500	-0.317
0.1750	-0.364	0.6666	-0.314
0.1833	-0.364	0.6833	-0.314
0.1916	-0.364	0.7000	-0.311
0.2000	-0.361	0.7166	-0.311
0.2083	-0.361	0.7333	-0.307
0.2166	-0.361	0.7500	-0.304
0.2250	-0.361	0.7666	-0.304
0.2333	-0.358	0.7833	-0.304
0.2416	-0.358	0.8000	-0.301
0.2500	-0.355	0.8166	-0.301
0.2583	-0.355	0.8333	-0.298
0.2666	-0.355	0.8500	-0.298
0.2750	-0.352	0.8666	-0.295
0.2833	-0.355	0.8833	-0.295
0.2916	-0.352	0.9000	-0.291
0.3000	-0.352	0.9166	-0.291
0.3083	-0.352	0.9333	-0.291
0.3166	-0.349	0.9500	-0.288

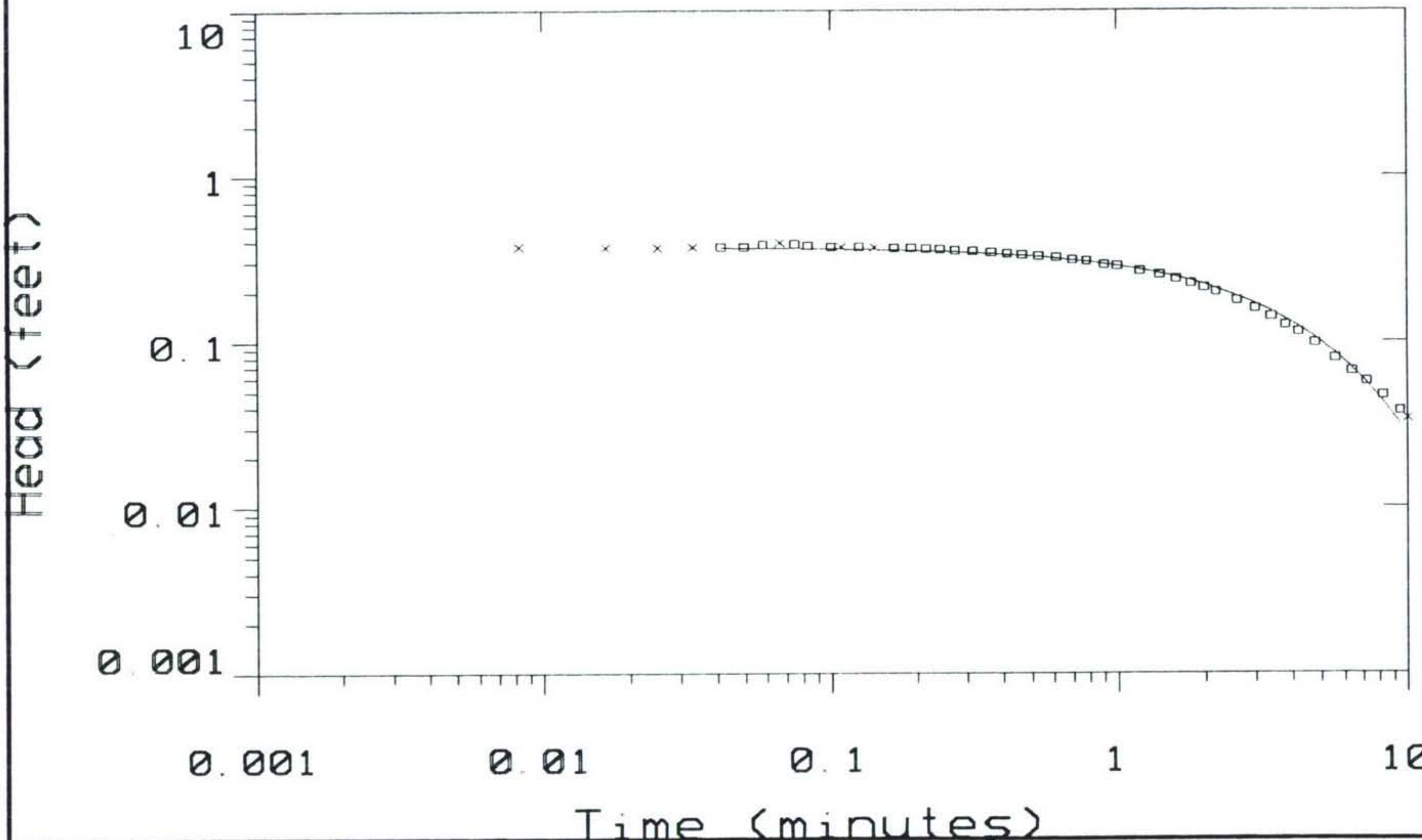
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M02X

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	21:11		Date	09/21 /93
Logger Test	2		INPUT 1 Level	(F)

Step 1 09/21 11:43:24

Elapsed Time	INPUT 1
0.9666	-0.288
0.9833	-0.285
1.0000	-0.285
1.2000	-0.266
1.4000	-0.253
1.6000	-0.238
1.8000	-0.225
2.0000	-0.212
2.2000	-0.199
2.4000	-0.187
2.6000	-0.177
2.8000	-0.168
3.0000	-0.158
3.2000	-0.149
3.4000	-0.142
3.6000	-0.133
3.8000	-0.126
4.0000	-0.120
4.2000	-0.114
4.4000	-0.107
4.6000	-0.104
4.8000	-0.098
5.0000	-0.095
5.2000	-0.088
5.4000	-0.085
5.6000	-0.079
5.8000	-0.076
6.0000	-0.072
6.2000	-0.069
6.4000	-0.066
6.6000	-0.063
6.8000	-0.060
7.0000	-0.060
7.2000	-0.057
7.4000	-0.053
7.6000	-0.053
7.8000	-0.050
8.0000	-0.047
8.2000	-0.047

Elapsed Time	INPUT 1
8.4000	-0.044
8.6000	-0.044
8.8000	-0.041
9.0000	-0.041
9.2000	-0.038
9.4000	-0.038
9.6000	-0.034
9.8000	-0.034
10.0000	-0.034
12.0000	-0.028
14.0000	-0.025
16.0000	-0.022
18.0000	-0.022



MODEL TYPE BOUWER and RICE

CONDUCTIVITY .0007933 ft/min

TRANSMISSIVITY .003593 sq. ft/min

INITIAL HEAD .3710 ft

Data Set P37M2S1   Date 9-21-93

for **USAEC**

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 4.530

SCREEN top 9.000 base 19.00

DIAMETER casing .3400 intake .3400

DEPTH Water Table 16.32 TD 20.85

Well Slug Test Data

Well: E3-P37-M02

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M03X

Reference	0.000
SG	1.000
Linearity	-0.000
Time	21:16
Logger Test	2

Scale Factor	9.990
Offset	-0.009
Delay mSEC	50.000
Date	09/21 /93
INPUT 2	Level (F)

Step 1 09/21 11:43:24

Elapsed Time	INPUT 2
0.0000	-0.615
0.0083	-0.589
0.0166	-0.564
0.0250	-0.548
0.0333	-0.529
0.0416	-0.517
0.0500	-0.504
0.0583	-0.492
0.0666	-0.479
0.0750	-0.469
0.0833	-0.454
0.0916	-0.447
0.1000	-0.438
0.1083	-0.425
0.1166	-0.416
0.1250	-0.410
0.1333	-0.400
0.1416	-0.391
0.1500	-0.384
0.1583	-0.375
0.1666	-0.365
0.1750	-0.356
0.1833	-0.346
0.1916	-0.337
0.2000	-0.328
0.2083	-0.315
0.2166	-0.302
0.2250	-0.290
0.2333	-0.277
0.2416	-0.261
0.2500	-0.249
0.2583	-0.236
0.2666	-0.223
0.2750	-0.211
0.2833	-0.198
0.2916	-0.189
0.3000	-0.179
0.3083	-0.170
0.3166	-0.160

Elapsed Time	INPUT 2
0.3250	-0.154
0.3333	-0.145
0.3500	-0.132
0.3666	-0.116
0.3833	-0.107
0.4000	-0.094
0.4166	-0.088
0.4333	-0.075
0.4500	-0.072
0.4666	-0.063
0.4833	-0.059
0.5000	-0.053
0.5166	-0.047
0.5333	-0.044
0.5500	-0.037
0.5666	-0.034
0.5833	-0.031
0.6000	-0.028
0.6166	-0.028
0.6333	-0.025
0.6500	-0.022
0.6666	-0.022
0.6833	-0.018
0.7000	-0.015
0.7166	-0.015
0.7333	-0.015
0.7500	-0.012
0.7666	-0.012
0.7833	-0.012
0.8000	-0.009
0.8166	-0.009
0.8333	-0.009
0.8500	-0.009
0.8666	-0.006
0.8833	-0.006
0.9000	-0.006
0.9166	-0.006
0.9333	-0.006
0.9500	-0.003

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P37-M03X

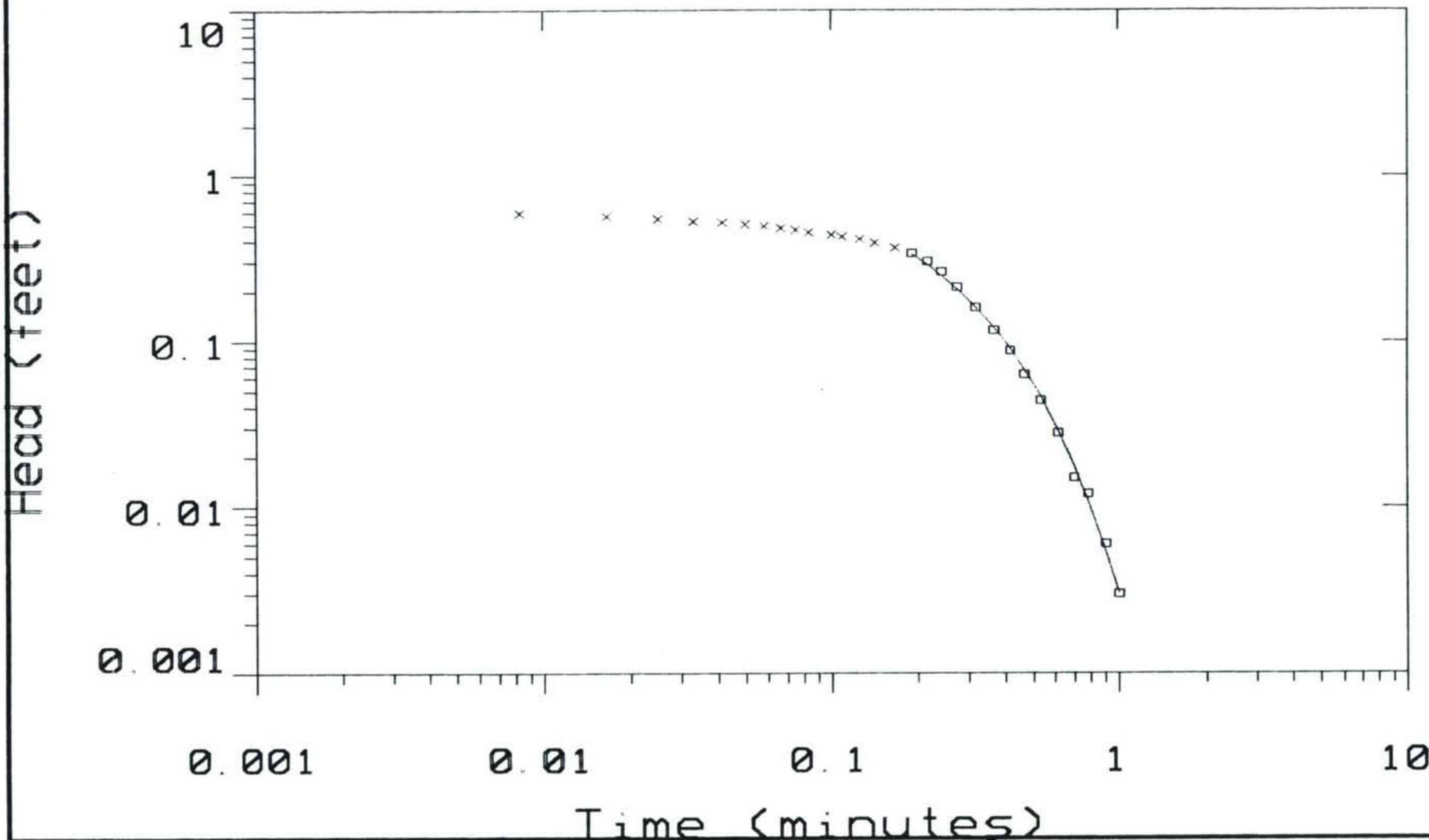
Reference	0.000
SG	1.000
Linearity	-0.000
Time	21:16
Logger Test	2

Scale Factor	9.990
Offset	-0.009
Delay mSEC	50.000
Date	09/21 /93
INPUT 2 Level (F)	

Step 1 09/21 11:43:24

Elapsed Time	INPUT 2
0.9666	-0.003
0.9833	-0.003
1.0000	-0.003
1.2000	0.000
1.4000	0.003
1.6000	0.003
1.8000	0.003
2.0000	0.003
2.2000	0.003
2.4000	0.006
2.6000	0.006
2.8000	0.006
3.0000	0.006
3.2000	0.006
3.4000	0.006
3.6000	0.006
3.8000	0.006
4.0000	0.006
4.2000	0.006
4.4000	0.006
4.6000	0.006
4.8000	0.006
5.0000	0.006
5.2000	0.006
5.4000	0.006
5.6000	0.006
5.8000	0.006
6.0000	0.006
6.2000	0.006
6.4000	0.006
6.6000	0.006
6.8000	0.006
7.0000	0.006
7.2000	0.006
7.4000	0.006
7.6000	0.006
7.8000	0.006
8.0000	0.006
8.2000	0.006

Elapsed Time	INPUT 2
8.4000	0.006
8.6000	0.006
8.8000	0.006
9.0000	0.006
9.2000	0.006
9.4000	0.006
9.6000	0.009
9.8000	0.006
10.0000	0.006
12.0000	0.006
14.0000	0.006
16.0000	0.006
18.0000	0.003



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 01656 ft/min

TRANSMISSIVITY 08100 sq ft/min

INITIAL HEAD 5890 ft

Data Set P37M3S1 | Date 9-21-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 4 890

SCREEN top 10 00 base 20 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 16 93 TD 21 82

Well Slug Test Data

Well: E3-P37-M03

SUDBURY, MA

SUDBURY

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P57-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	19:17	Date	09/23 /93
Logger Test	5	INPUT 1 Level (F)	

Step 1 09/23 15:38:17

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-2.072	0.3250	-1.612
0.0083	-2.028	0.3333	-1.609
0.0166	-1.999	0.3500	-1.596
0.0250	-1.974	0.3666	-1.590
0.0333	-1.955	0.3833	-1.580
0.0416	-1.933	0.4000	-1.574
0.0500	-1.974	0.4166	-1.564
0.0583	-1.990	0.4333	-1.558
0.0666	-1.894	0.4500	-1.552
0.0750	-1.860	0.4666	-1.545
0.0833	-1.847	0.4833	-1.539
0.0916	-1.837	0.5000	-1.533
0.1000	-1.825	0.5166	-1.526
0.1083	-1.815	0.5333	-1.520
0.1166	-1.802	0.5500	-1.517
0.1250	-1.799	0.5666	-1.510
0.1333	-1.790	0.5833	-1.504
0.1416	-1.783	0.6000	-1.498
0.1500	-1.777	0.6166	-1.495
0.1583	-1.774	0.6333	-1.488
0.1666	-1.774	0.6500	-1.485
0.1750	-1.742	0.6666	-1.479
0.1833	-1.733	0.6833	-1.475
0.1916	-1.723	0.7000	-1.472
0.2000	-1.717	0.7166	-1.466
0.2083	-1.710	0.7333	-1.463
0.2166	-1.704	0.7500	-1.460
0.2250	-1.698	0.7666	-1.456
0.2333	-1.691	0.7833	-1.450
0.2416	-1.685	0.8000	-1.447
0.2500	-1.679	0.8166	-1.444
0.2583	-1.672	0.8333	-1.437
0.2666	-1.666	0.8500	-1.434
0.2750	-1.663	0.8666	-1.431
0.2833	-1.653	0.8833	-1.428
0.2916	-1.634	0.9000	-1.425
0.3000	-1.622	0.9166	-1.422
0.3083	-1.618	0.9333	-1.418
0.3166	-1.615	0.9500	-1.415

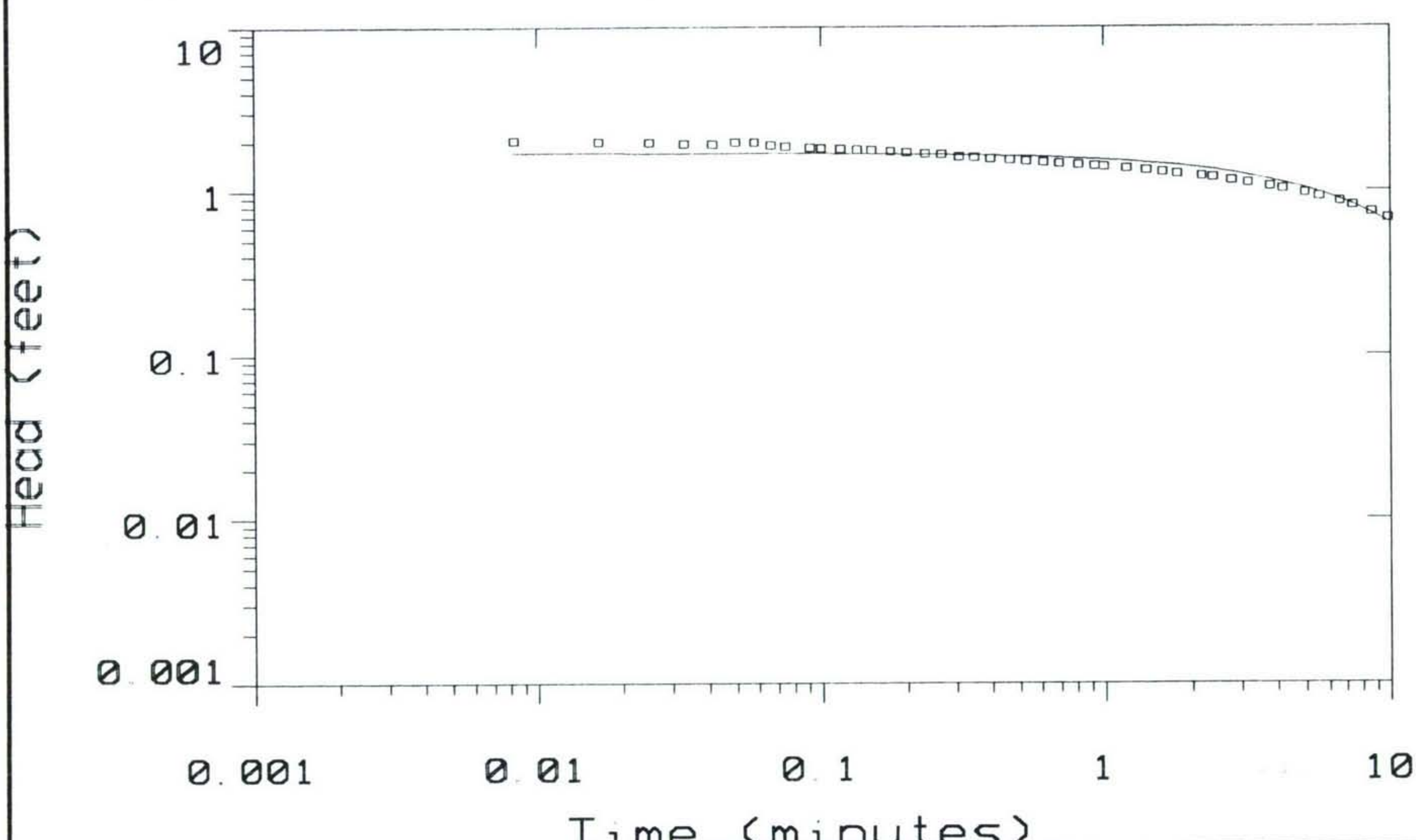
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P57-M01X

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	19:17		Date	09/23 /93
Logger Test	5		INPUT 1 Level	(F)

Step 1 09/23 15:38:17

Elapsed Time	INPUT 1
0.9666	-1.412
0.9833	-1.409
1.0000	-1.406
1.2000	-1.368
1.4000	-1.336
1.6000	-1.304
1.8000	-1.276
2.0000	-1.250
2.2000	-1.228
2.4000	-1.206
2.6000	-1.183
2.8000	-1.158
3.0000	-1.139
3.2000	-1.120
3.4000	-1.101
3.6000	-1.082
3.8000	-1.063
4.0000	-1.047
4.2000	-1.028
4.4000	-1.012
4.6000	-0.996
4.8000	-0.980
5.0000	-0.964
5.2000	-0.949
5.4000	-0.936
5.6000	-0.920
5.8000	-0.907
6.0000	-0.895
6.2000	-0.882
6.4000	-0.869
6.6000	-0.857
6.8000	-0.844
7.0000	-0.831
7.2000	-0.818
7.4000	-0.806
7.6000	-0.796
7.8000	-0.784
8.0000	-0.774
8.2000	-0.761

Elapsed Time	INPUT 1
8.4000	-0.752
8.6000	-0.739
8.8000	-0.730
9.0000	-0.720
9.2000	-0.707
9.4000	-0.698
9.6000	-0.688
9.8000	-0.676
10.0000	-0.666
12.0000	-0.565
14.0000	-0.441
16.0000	-0.333
18.0000	-0.269
20.0000	-0.222
22.0000	-0.180
24.0000	-0.152
26.0000	-0.130
28.0000	-0.107
30.0000	-0.092



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY .0004048 ft/min	by Ecology & Environment	Well: E3-P57-M01
TRANSMISSIVITY .003432 sq ft/min	WELL DATA Units ft	SUDBURY, MA
INITIAL HEAD 2.028 ft	AQUIFER Endless	SUDBURY
Data Set P57M1S1 / Date 9-23-93	THICKNESS 8.480	
	SCREEN top 9.000 base 19.00	
	DIAMETER casing .3400 intake .3400	
	DEPTH Water Table 12.34 TD 20.82	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M01X

Reference	0.000		Scale Factor	10.051
SG	1.000		Offset	-0.010
Linearity	0.004		Delay mSEC	50.000
Time	21:22		Date	09/21 /93
Logger Test	1		INPUT 1	Level (F)

Step 1 09/21 09:49:08

Elapsed Time	INPUT 1	Elapsed Time	INPUT 1
0.0000	-1.225	0.3250	-0.295
0.0083	-1.187	0.3333	-0.282
0.0166	-1.145	0.3500	-0.260
0.0250	-1.114	0.3666	-0.241
0.0333	-1.072	0.3833	-0.225
0.0416	-1.037	0.4000	-0.206
0.0500	-1.009	0.4166	-0.190
0.0583	-0.974	0.4333	-0.174
0.0666	-0.942	0.4500	-0.158
0.0750	-0.911	0.4666	-0.142
0.0833	-0.879	0.4833	-0.139
0.0916	-0.847	0.5000	-0.146
0.1000	-0.825	0.5166	-0.142
0.1083	-0.796	0.5333	-0.130
0.1166	-0.768	0.5500	-0.126
0.1250	-0.742	0.5666	-0.117
0.1333	-0.720	0.5833	-0.111
0.1416	-0.695	0.6000	-0.104
0.1500	-0.669	0.6166	-0.098
0.1583	-0.647	0.6333	-0.092
0.1666	-0.625	0.6500	-0.085
0.1750	-0.561	0.6666	-0.079
0.1833	-0.545	0.6833	-0.076
0.1916	-0.526	0.7000	-0.069
0.2000	-0.504	0.7166	-0.066
0.2083	-0.485	0.7333	-0.063
0.2166	-0.469	0.7500	-0.060
0.2250	-0.450	0.7666	-0.057
0.2333	-0.438	0.7833	-0.053
0.2416	-0.422	0.8000	-0.050
0.2500	-0.406	0.8166	-0.047
0.2583	-0.393	0.8333	-0.044
0.2666	-0.377	0.8500	-0.044
0.2750	-0.365	0.8666	-0.041
0.2833	-0.352	0.8833	-0.038
0.2916	-0.336	0.9000	-0.034
0.3000	-0.326	0.9166	-0.034
0.3083	-0.317	0.9333	-0.031
0.3166	-0.304	0.9500	-0.028

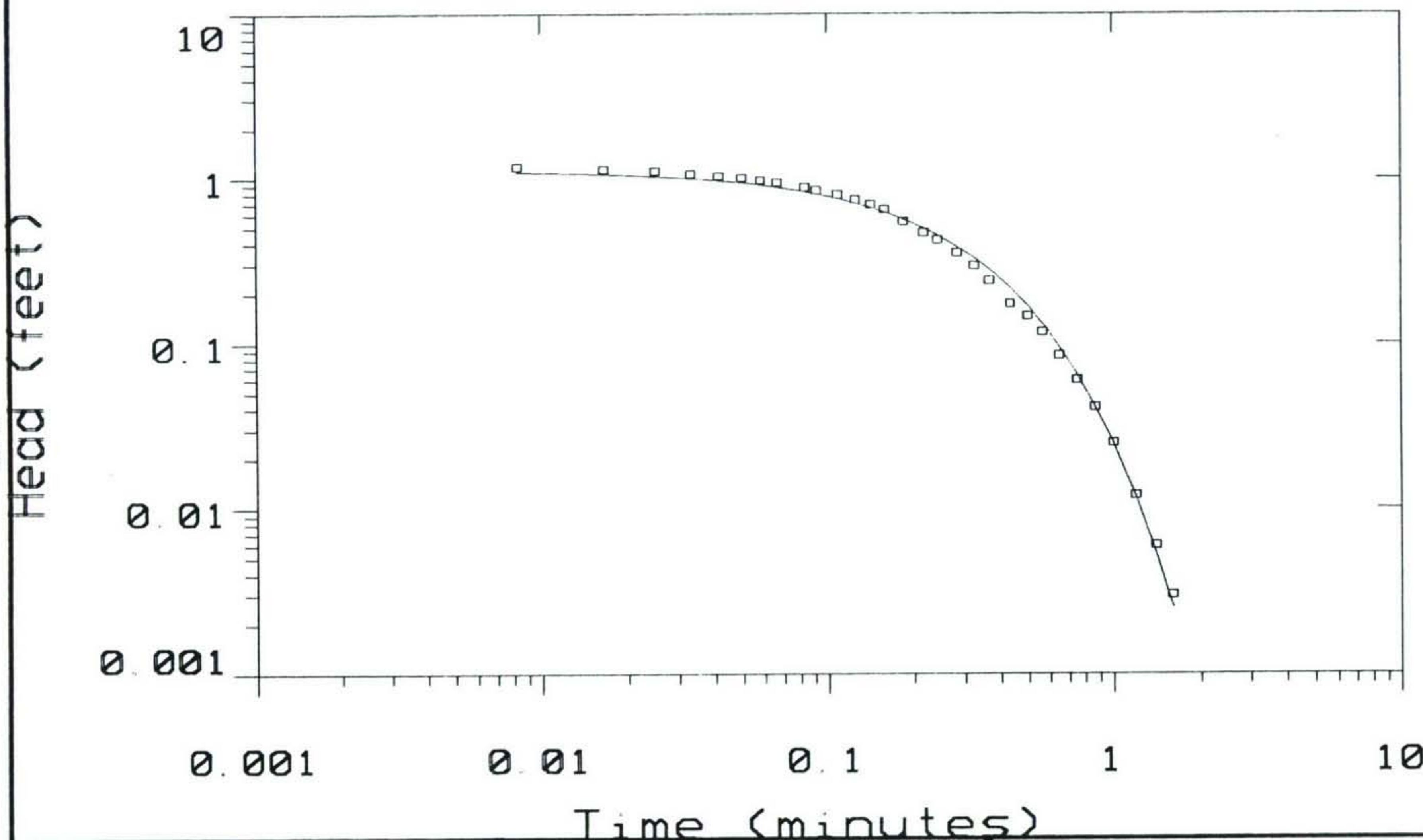
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M01X

Reference	0.000	Scale Factor	10.051
SG	1.000	Offset	-0.010
Linearity	0.004	Delay mSEC	50.000
Time	21:22	Date	09/21 /93
Logger Test	1	INPUT 1 Level (F)	

Step 1 09/21 09:49:08

Elapsed Time	INPUT 1
0.9666	-0.028
0.9833	-0.028
1.0000	-0.025
1.2000	-0.012
1.4000	-0.006
1.6000	-0.003
1.8000	0.000
2.0000	0.003
2.2000	0.006
2.4000	0.006
2.6000	0.006
2.8000	0.009
3.0000	0.009
3.2000	0.012
3.4000	0.012
3.6000	0.012
3.8000	0.015
4.0000	0.015
4.2000	0.019
4.4000	0.019
4.6000	0.019
4.8000	0.022
5.0000	0.022
5.2000	0.022
5.4000	0.022
5.6000	0.022
5.8000	0.022
6.0000	0.022
6.2000	0.025
6.4000	0.025
6.6000	0.025
6.8000	0.025
7.0000	0.025
7.2000	0.025
7.4000	0.025
7.6000	0.025
7.8000	0.028
8.0000	0.028
8.2000	0.028

Elapsed Time	INPUT 1
8.4000	0.028
8.6000	0.028
8.8000	0.028
9.0000	0.028
9.2000	0.028
9.4000	0.028
9.6000	0.028
9.8000	0.028
10.0000	0.028
12.0000	0.028
14.0000	0.031
16.0000	0.031
18.0000	0.031
20.0000	0.031
22.0000	0.031
24.0000	0.031
26.0000	0.031
28.0000	0.031
30.0000	0.031
32.0000	0.031
34.0000	0.031



MODEL TYPE BOUWER and RICE	for USAEC	Well Slug Test Data
CONDUCTIVITY 02013 ft/min	by Ecology & Environment	Well: E3-P58-M01
TRANSMISSIVITY 8376 sq. ft/min	WELL DATA Units ft AQUIFER Endless THICKNESS 41 61	SUDBURY, MA
INITIAL HEAD 1 187 ft	SCREEN top 39 00 base 49 00 DIAMETER casing 3400 intake 3400	SUDBURY
Data Set P58M1S1 / Date 9-21-93	DEPTH Water Table 8 600 TD 50 21	

ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M02X

Reference	0.000
SG	1.000
Linearity	-0.000
Time	21:28
Logger Test	1

Scale Factor	9.990
Offset	-0.009
Delay mSEC	50.000
Date	09/21 /93
INPUT 2 Level	(F)

Step 1 09/21 09:49:08

Elapsed Time	INPUT 2
0.0000	-1.715
0.0083	-2.450
0.0166	-3.592
0.0250	-3.494
0.0333	-3.488
0.0416	-3.513
0.0500	-3.412
0.0583	-3.371
0.0666	-3.361
0.0750	-3.324
0.0833	-3.317
0.0916	-3.324
0.1000	-3.301
0.1083	-3.232
0.1166	-3.194
0.1250	-3.172
0.1333	-3.153
0.1416	-3.163
0.1500	-3.147
0.1583	-3.122
0.1666	-3.078
0.1750	-3.049
0.1833	-3.030
0.1916	-3.005
0.2000	-2.996
0.2083	-2.967
0.2166	-2.948
0.2250	-2.926
0.2333	-2.917
0.2416	-2.898
0.2500	-2.882
0.2583	-2.863
0.2666	-2.844
0.2750	-2.828
0.2833	-2.813
0.2916	-2.794
0.3000	-2.775
0.3083	-2.762
0.3166	-2.743

Elapsed Time	INPUT 2
0.3250	-2.727
0.3333	-2.712
0.3500	-2.680
0.3666	-2.649
0.3833	-2.617
0.4000	-2.589
0.4166	-2.560
0.4333	-2.529
0.4500	-2.500
0.4666	-2.472
0.4833	-2.440
0.5000	-2.412
0.5166	-2.387
0.5333	-2.358
0.5500	-2.333
0.5666	-2.305
0.5833	-2.280
0.6000	-2.254
0.6166	-2.226
0.6333	-2.201
0.6500	-2.176
0.6666	-2.150
0.6833	-2.125
0.7000	-2.103
0.7166	-2.078
0.7333	-2.056
0.7500	-2.030
0.7666	-2.008
0.7833	-1.986
0.8000	-1.964
0.8166	-1.939
0.8333	-1.920
0.8500	-1.898
0.8666	-1.876
0.8833	-1.854
0.9000	-1.832
0.9166	-1.813
0.9333	-1.791
0.9500	-1.772

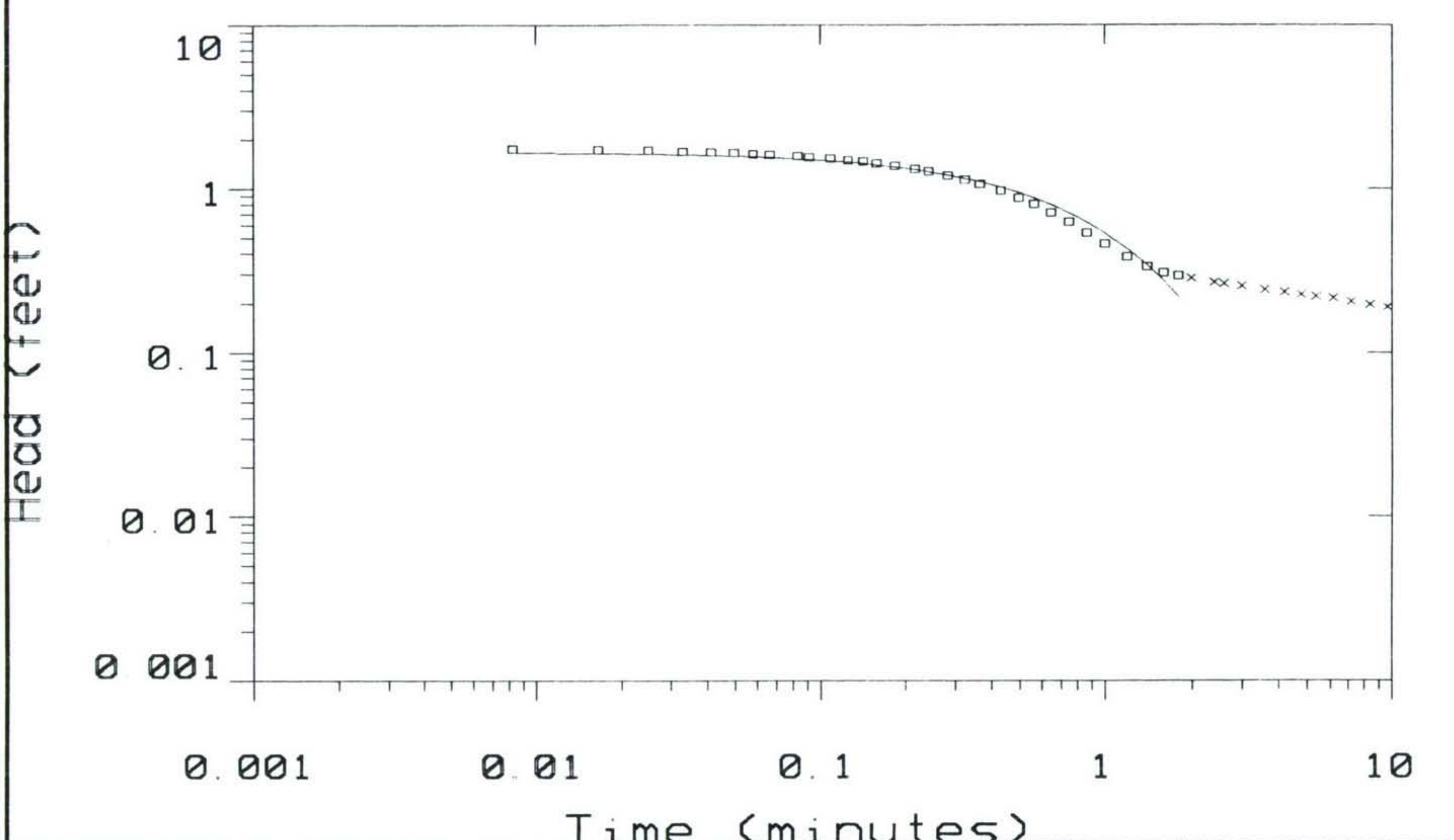
ECOLOGY AND ENVIRONMENT
SE2000
Environmental Logger
Unit# HMC-S
Monitoring Well E3-P58-M02X

Reference	0.000	Scale Factor	9.990
SG	1.000	Offset	-0.009
Linearity	-0.000	Delay mSEC	50.000
Time	21:28	Date	09/21 /93
Logger Test	1	INPUT 2 Level (F)	

Step 1 09/21 09:49:08

Elapsed Time	INPUT 2
0.9666	-1.750
0.9833	-1.731
1.0000	-1.712
1.2000	-1.494
1.4000	-1.302
1.6000	-1.138
1.8000	-0.996
2.0000	-0.873
2.2000	-0.763
2.4000	-0.668
2.6000	-0.586
2.8000	-0.517
3.0000	-0.450
3.2000	-0.400
3.4000	-0.353
3.6000	-0.312
3.8000	-0.277
4.0000	-0.245
4.2000	-0.220
4.4000	-0.198
4.6000	-0.179
4.8000	-0.160
5.0000	-0.145
5.2000	-0.132
5.4000	-0.119
5.6000	-0.110
5.8000	-0.100
6.0000	-0.094
6.2000	-0.088
6.4000	-0.081
6.6000	-0.075
6.8000	-0.069
7.0000	-0.066
7.2000	-0.063
7.4000	-0.059
7.6000	-0.056
7.8000	-0.053
8.0000	-0.053
8.2000	-0.050

Elapsed Time	INPUT 2
8.4000	-0.050
8.6000	-0.050
8.8000	-0.047
9.0000	-0.044
9.2000	-0.044
9.4000	-0.044
9.6000	-0.040
9.8000	-0.040
10.0000	-0.037
12.0000	-0.034
14.0000	-0.031
16.0000	-0.031
18.0000	-0.031
20.0000	-0.028
22.0000	-0.028
24.0000	-0.028
26.0000	-0.028
28.0000	-0.025
30.0000	-0.025
32.0000	-0.025
34.0000	-0.025



MODEL TYPE BOUWER and RICE

CONDUCTIVITY 004580 ft/min

TRANSMISSIVITY 04475 sq ft/min

INITIAL HEAD 1 742 ft

Data Set F58M2S1 | Date 9-21-93

for USAEC

by Ecology & Environment

WELL DATA Units ft

AQUIFER Endless

THICKNESS 9 770

SCREEN top 8 000 base 18 00

DIAMETER casing 3400 intake 3400

DEPTH Water Table 9 970 TD 19 74

Well Slug Test Data

Well: E3-P58-M02

SUDBURY, MA

SUDBURY

APPENDIX H

GROUNDWATER MODEL REPORT

GROUNDWATER FLOW MODEL FOR SUDBURY TRAINING ANNEX AND VICINITY, MASSACHUSETTS

Prepared for

Ecology and Environment, Inc.
Lancaster, New York

August 8, 1994

GROUNDWATER FLOW MODEL FOR SUDBURY TRAINING ANNEX AND VICINITY, MASSACHUSETTS

Prepared for

Ecology and Environment, Inc.
Lancaster, New York

Prepared by

HydroGeoLogic, Inc.
Herndon, Virginia

August 8, 1994

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PREFACE

The three-dimensional groundwater flow model of the Sudbury Training Annex (the Annex) was prepared by HydroGeoLogic, Inc., under Subcontract UC-6968 for Ecology and Environment, Inc. (E&E). E&E requested this groundwater model to support environmental investigations being conducted at the Annex for the United States Army Environmental Center under Delivery Order No. 0004 of Contract No. DAAA15-90-D-0012. Information from this groundwater model generally confirms the assessment of Annex-wide groundwater flow described in E&E's Draft Phase II Site Investigations/Remedial Investigations Report.

EXECUTIVE SUMMARY

Fort Devens Sudbury Training Annex is a U.S. Army training and research site in Middlesex County, MA. The objective of this study was to develop a regional three dimensional groundwater model capable of simulating subsurface flow at the annex and vicinity. This work is part of ongoing environmental studies at the site.

The site geology consists of three distinct units; a bedrock unit overlain by a thin layer of glacial till with deposits of glacial outwash on top of the till. The bedrock outcrops at a number of locations at the site. In most places it is covered with glacial deposits varying from less than a foot to over 100 feet in thickness. A bedrock elevation map was constructed for the site based on prior investigative reports and USGS topographic maps.

All three geological units contain groundwater, however, the glacial outwash is the most important source of groundwater in the area. Groundwater in the bedrock unit is stored in openings along joints and cleavage planes of the bedrock formations. However, there are no reports on the presence of faults or other major fracture zones in the bedrock that would enable the formations to produce significant amounts of water. The till is comprised of highly compact and poorly sorted boulders, gravel, sand, silt, and clay. Therefore, it has low permeability which makes it a poor source of groundwater. The outwash contains the largest body of groundwater that is readily available. It overlies the till and is the upper layer of the glacial deposits throughout most of the site. The material in the upper portions of the outwash is primarily made of coarse sand and gravel with relatively high permeability, in contrast to its lower beds which contain finer sand and silt.

The groundwater flow dynamics at the site is hydrogeologically complex but conceptually simple. Water enters the subsurface in the form of precipitation flowing towards drainage areas formed by streams, ponds, and marshes at the site. The modeled domain therefore consists of several watershed regions.

The three-dimensional subsurface flow model developed for the site simulates flow in all three geological units. The USGS software code MODFLOW was utilized for constructing the site model. In order for the model to perform reliably, it was first calibrated with respect to the observed or interpreted water table. The interpreted water table was constructed utilizing information from previous investigative studies and data from monitoring wells and surface water gauges. Initial estimates of the hydrogeologic properties and boundary conditions for the model were obtained after carefully reviewing all available data sources pertinent to the site. Numerous simulations were then performed while adjusting the key aquifer parameters until the simulated water table was deemed to be in good agreement with the interpreted water table. The model was then considered calibrated and a reliable tool for conducting predictive and remedial investigative studies.

The model confirmed the subsurface flow dynamics hypothesized for the site. Flow emanates from the outcrops, traversing all three geological units, prior to discharging into the adjacent surface water bodies. The model delineates in detail all the major and minor watersheds in the area. The only major withdrawal in the area is through pumping surface water from White Pond by the Town of Maynard. The model satisfactorily accounts for the estimated contribution of groundwater towards this withdrawal.

In order to further increase confidence in the model, sensitivity analyses were conducted by varying a number of key input parameters and noting the response of the model to the variations. The calibrated model was found to be strongly sensitive only to the ratio of areal recharge and horizontal hydraulic conductivity in the outwash. Since the calibrated recharge to the model is well documented, the model was considered well calibrated and a reliable tool for both predictive and remedial investigation purposes.

1.0 INTRODUCTION

1.1 OVERVIEW

The Fort Devens Sudbury Training Annex is a U.S. Army training and research site located about 20 miles west of Boston in Middlesex County, Massachusetts (Figure 1.1). The site consists of two separate portions of land which incorporate sections of the towns of Hudson, Marlborough, Maynard, Stow and Sudbury. It lies entirely within the Maynard 7.5 minute United States Geological Survey (USGS) topographic map. The total area of the site is approximately 4.3 square miles. Figure 1.2 illustrates the location of the Annex and adjoining areas. The northern portion of the Annex contains facilities for military training and research, and the southern portion currently contains a small housing area for military personnel.

The primary objective of this study is to develop a groundwater flow model capable of assisting in hydrogeologic investigations for the purpose of studying the long-term cumulative impacts of continuous pumping of water and the migration of potential contaminants in and around the site. This work is part of ongoing environmental studies at the site. The model simulates groundwater flow within three hydrogeological units identified beneath the site area. They are the glacial outwash at the top (the primary source of groundwater), underlain by a thin layer of till, and igneous/metamorphic crystalline bedrock at the bottom. The model accounts for major hydrological processes such as areal recharge, pumping and groundwater discharge to streams and ponds. The model was developed using the USGS numerical modeling code MODFLOW (McDonald and Harbaugh, 1988).

1.2 SCOPE OF WORK

The scope of work for this project consists of the following major tasks:

- Review, compilation, and analysis of existing hydrogeologic data for the region.

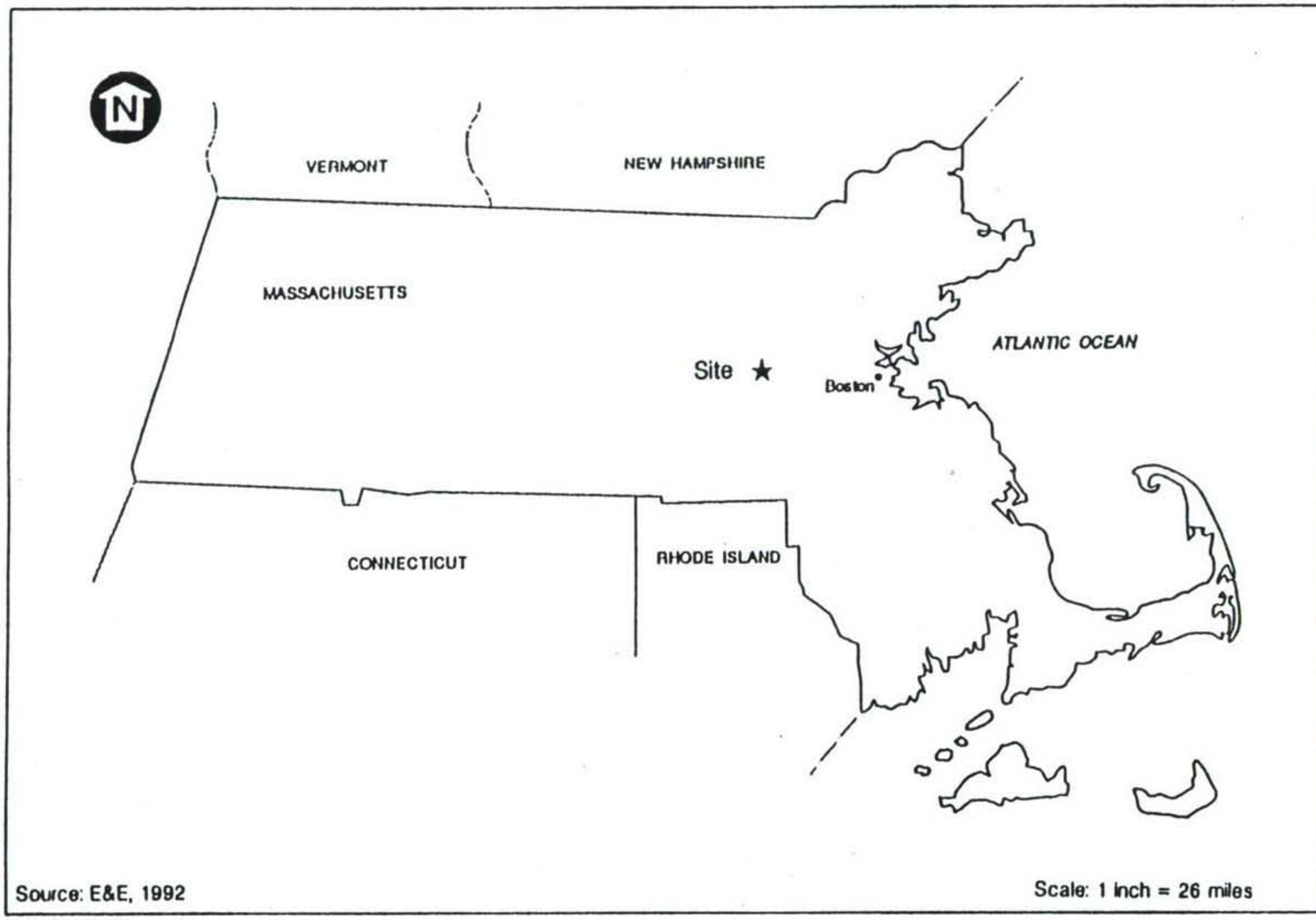

Figure 1.1 Sudbury Annex Location Map.

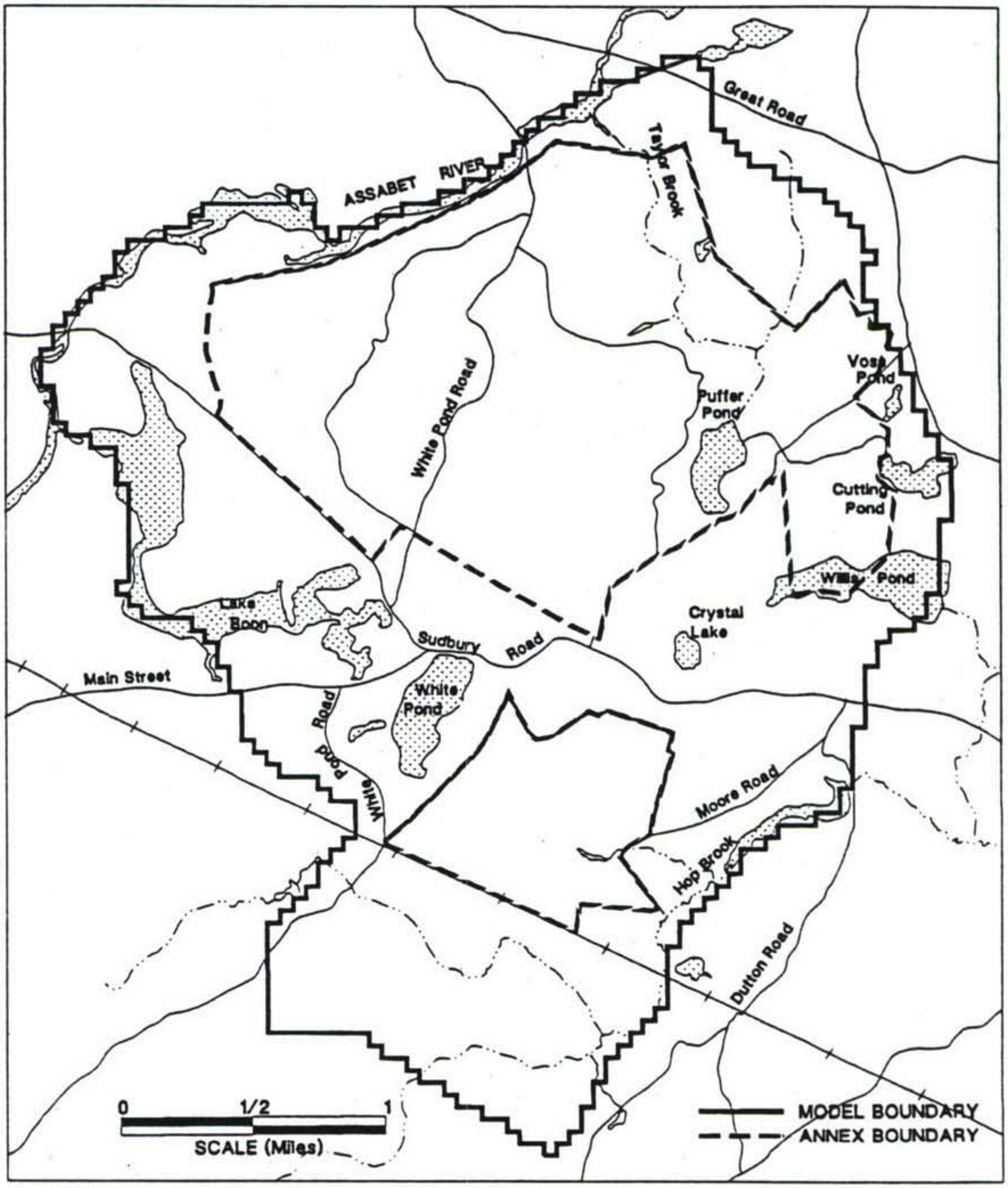

Figure 1.2 Sudbury Annex Site Map.

- Construction of a calibrated three-dimensional groundwater flow model capable of simulating existing and future hydrologic conditions at the site.

- Performing sensitivity studies in order to demonstrate reliability of model, and assist in planning field investigations.

- Documenting data sources and the model development process in a comprehensive report.

1.3 ORGANIZATION OF REPORT

This report is divided into 4 chapters. Chapter 1 describes the project objective. Chapter 2 describes the overall environmental setting. Chapter 3 describes and discusses the construction and calibration of the numerical model, simulated results, and the sensitivity analysis. Chapter 4 consists of a brief summary and conclusions.

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2.0 ENVIRONMENTAL SETTING

2.1 TOPOGRAPHY AND CLIMATE

The site topography is generally flat and is characterized by small scattered hills, ponds and streams. The altitude of the land surface varies from 320 ft above mean sea level (amsl) at the hills in the northern portion of the site to about 150 ft at the stream valley in the southeast portion. The altitude of the flat plains is between 180 to 210 ft. The climate in the area is humid with a mean annual precipitation of about 44 inches per year. Rainfall is generally uniformly distributed throughout the year with monthly averages ranging from 3 to 4 inches. Nearly half of the precipitation is lost to evaporation and transpiration (Perlmutter, 1962).

There are many swamps and undrained depressions in the plain that cause irregular drainage commonly encountered in glaciated regions. Many small streams that drain the area flow north towards the Assabet River, which forms the northern boundary of the study site (see Figure 1.2), or to several ponds and lakes in different parts of the site. The surface water bodies are also discharge points for groundwater, and therefore significantly influence movement of groundwater within the study area. The southeast portion of the site drains to Willis Pond and Hop Brook which are tributaries of the Sudbury River. The Assabet and Sudbury Rivers join northeast of the site to form the Concord River.

2.2 GEOLOGY

The site geology consists of three distinct units; a bedrock unit overlain by a thin layer of glacial till and deposits of glacial outwash on the top. The bedrock under the site consists of Paleozoic age igneous and metamorphic rocks. Hansen (1956) investigated the geologic history of the site area and mapped five distinct geologic units. From oldest to youngest, they are: i) the Marlboro formation (schist), which lies underneath a long narrow strip that extends from the southern border of the study site through White Pond, Puffer Pond and Vose Hill; ii) gabbro-

diorite, which occupies the Willis Pond and vicinity; iii) the Dedham granodiorite, which lies underneath the southeastern section of the site; iv) the Nashoba formation (gneiss), which underlies the northwestern corner of the site; and v) the Gospel Hill gneiss, which occupies the area under the center of the Armex, between the Nashoba and Marlboro formations.

Perlmutter (1962) provided a detailed description of the site geologic history as follows:

> "The sediments that formed the oldest bedrock unit, the Marlboro formation, were deposited in Precambrian time and consisted of sand, silt, clay and perhaps some volcanic material. Sometime during Precambrian, these sediments were metamorphosed into schistose rocks. Later, in early Paleozoic time, these rocks were intruded by large bodies of igneous material, which upon cooling formed the Salem(?) gabbro-diorite and the Dedham granodiorite. During Carboniferous time, sediments were deposited on the surface of the older rocks and at the close of the period all the rocks were uplifted, folded and metamorphosed, and schistose and gneiss rocks of the Nashoba formation and Gospel Hill gneiss were formed.
>
> The uplift in late Carboniferous time was followed by predominantly erosional periods and by early Cretaceous time the land surface had been reduced to peneplain. During the Tertiary age, renewed uplift and extensive erosion occurred. The first major streams developed on the newly uplifted surface were of the consequent type and generally ignored the structure of the bedrock, but many tributary streams developed following the northeastward-trending belts of relatively soft rock and thus developed a regional trellis drainage pattern. Dissection of the Cretaceous peneplain was completed by late Pliocene time, and an irregular bedrock surface was exposed to ice sheets during the subsequent Pleistocene epoch."

The bedrock outcrops at a number of locations at the site. In most places it is covered with glacial deposits varying from less than a foot to over 100 feet in thickness. Two seismic surveys were carried out at the site by the USGS (Perlmutter, 1962), and by the DuFrense-Henry (1982) to obtain information on the surface configuration of the bedrock unit. The USGS study covered the southern part of the site; specifically the area east of White Pond and west of Hop Brook. The second study was limited to a relatively small area near Tuttle Hill and along Taylor Brook. Both studies were part of groundwater supply investigations conducted in the area, and were accompanied by the drilling of boreholes to the bedrock. Both studies reported that the bedrock

surface elevation is highly irregular with depths ranging from less than a foot to more than 100 ft below land surface.

A bedrock elevation map (Figure 2.1) was constructed for the site based on information contained in the above mentioned studies. Bedrock elevation in the southern part of the Annex was mapped by Perlmutter (1962). DuFrense-Henry (1982) generated limited bedrock data from a seismic study which included borehole drilling carried out near the Tuttle Hill area. Bedrock elevations in areas where data was not available or insufficient has been estimated by extrapolating trends from data in the investigative studies. Specifically, it was noted that the depth to bedrock surface varies from a maximum of 90 ft below the surface, mainly in the valleys, to a minimum of zero in areas where the bedrock is exposed.

The glacial till which overlies the bedrock is an unstratified and irregular layer that consists of poorly sorted boulders, gravel, sand, silt and clay. Perlmutter (1962) described this unit as discontinuous patches of different thickness in areas where the bedrock surface is at shallow depths, and as thick elongated bodies in the form of drumlins bordered by outwash in places where the bedrock surface is deeper. The thickness of the till has been reported to vary from a few inches to over 40 ft.

The glacial outwash, which is the major source of groundwater in the area, overlies the till. Perlmutter (1962) divided the outwash into two major types: i) Periglacial deposits and ii) Ice-contact deposits. The periglacial deposits in the form of broad outwash plains and sediments in lake bottoms were deposited by streams originating from melting ice. These deposits are made of comparatively well-stratified fine to coarse textured sand, gravel and silt. Most of the finer material is located in deeper beds with thicknesses over 55 ft in lake beds. The ice-contact deposits in the form of elongated mounds called eskers and roughly circular hills called kames are a result of glacial stream action on the landscape. The stratification in these deposits is from poor to good, and grain size distribution varies widely from boulder to clay. The sand and gravel size particles are predominantly quartz while smaller particles (silt and clay) consist mainly of quartz and several types of feldspars.

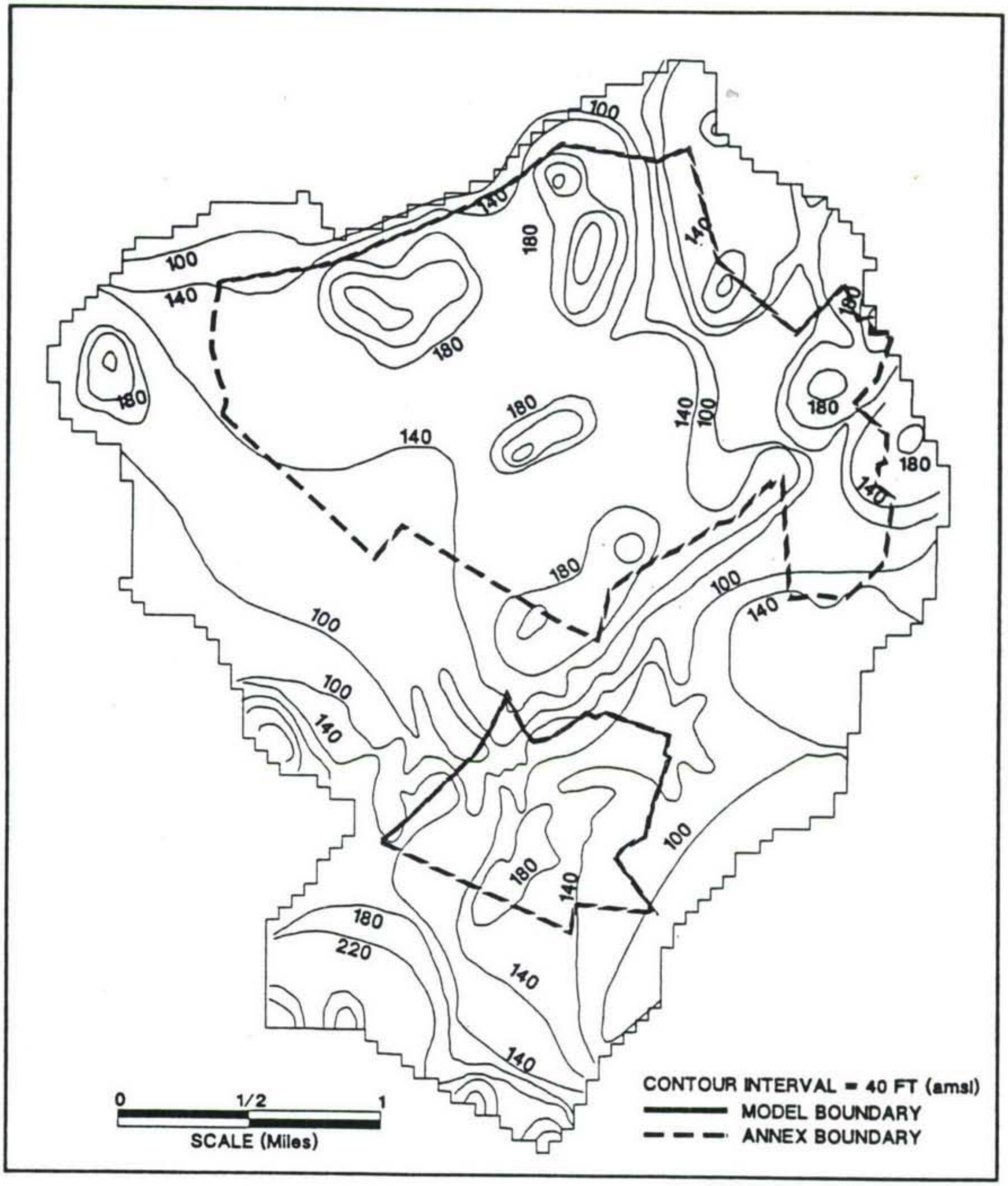


Figure 2.1 Altitude of the top of Bedrock unit.

2.3 HYDROGEOLOGY

All three geological units contain groundwater, however, the glacial outwash is the most important source of groundwater in the area. The groundwater in the bedrock unit is stored in openings along joints and cleavage planes of the bedrock formations discussed in the previous section. There are no reports on the presence of faults or other major fracture zones in the bedrock that would enable the formations to produce significant amounts of water. Groundwater yields of wells drilled into the bedrock were reported (Perlmutter, 1962) to be 3 to 7 gallons per minute (gpm), with static water levels at 24 to 30 ft below the land surface. A small number of domestic wells obtain groundwater from the bedrock units.

The thickness of the till which overlies the bedrock varies from a few inches to over 40 ft in some areas. As mentioned earlier, the till is comprised of highly compact and poorly sorted sand, silt and clay. Consequently, it has a low permeability which makes it a poor source of groundwater.

The outwash contains the largest body of groundwater that is readily available. It overlies the till and is the upper layer of the glacial deposits throughout the site. The hydrogeological properties of the outwash vary with depth. The material in the upper portions of the outwash is primarily made of coarse sand and gravel with relatively high permeability, in contrast to its lower beds which contain finer sand and silt. The coarse grained upper beds are generally 15 to 30 ft thick, however, the total thickness of the outwash varies from a few feet in the vicinity of till hills and bedrock outcrops to about 100 ft in the valleys where streams and lakes are located. The water table is generally less than 15 ft below the land surface. The saturated thickness of the outwash varies widely from a few feet at the base of the hills to 80 ft in the valleys, with an average thickness of about 50 ft. A layer of alluvium several feet thick overlies the outwash in many of the wetlands scattered throughout the site.

A detailed aquifer test was performed by the USGS using a 10-inch diameter water-supply well located approximately 3500 ft east of White Pond in September 1955 (Perlmutter, 1962). Water

level measurements were made in 20 observation wells. The initial thickness of the saturated zone at the pumping well was 45 ft. The well was pumped at rate of 603 gpm. After 50 hrs of pumping a specific capacity of 32 gpm per foot of drawdown was observed at the pumping well. The drawdown decreased from 6.5 ft at a distance of 7 ft from the pumping well to 0.34 ft at a location 440 ft away. A transmissivity value of 34,000 gpd per foot was computed for the aquifer from the data gathered from this test. The corresponding hydraulic conductivity was 101 ft per day (Perlmutter, 1962).

Ecology and Environment, Inc. (E&E, 1994) conducted slug tests at some of the monitoring wells at the site in 1992, and compiled a data base of measured hydraulic conductivities. Figure 2.2 shows the locations of the test sites, and Table 2.1 lists the measured values. The measured hydraulic conductivities range from 0.1 to 45 feet per day. As expected, values in the lower end of the range lie near the foot of the hills, and high values are obtained in the outwash. Most of the wells from which slug test data was obtained were shallow wells screened close to the water table, therefore, measurements made in these wells may not be representative of the entire saturated thickness of the aquifer.

Groundwater elevation in the outwash unit is highly correlated to the topographic features at the site. The water table is highest in the vicinity of the hills and is lowest in the marshes, streams and ponds where the water table is exposed. Therefore, groundwater flow is towards ponds and streams in all parts of the site except in the north where groundwater is discharged directly to the Assabet River. Most of the ponds are connected by streams. Subsurface flow from the uplands into the low lying surface water features is exemplified in the cross-section presented in Figure 2.3. The location of the cross-section is provided in Figure 2.4. The water table is over 200 ft above mean sea level (amsl) in higher topographic locations and varies from 195 to 180 ft (amsl) in most parts of the outwash, except in the Hop Brook area where it is between 170 and 160 ft (amsl). It has been noted that the seasonal variations of the water table is quite minor (Perlmutter, 1962), to the order of a few feet, and that no significant long-term variations have occurred at the site (Hussein Aldis, E&E, personnel communication). Therefore, for purposes of this study, an average annual water table surface (Figure 2.5) was constructed

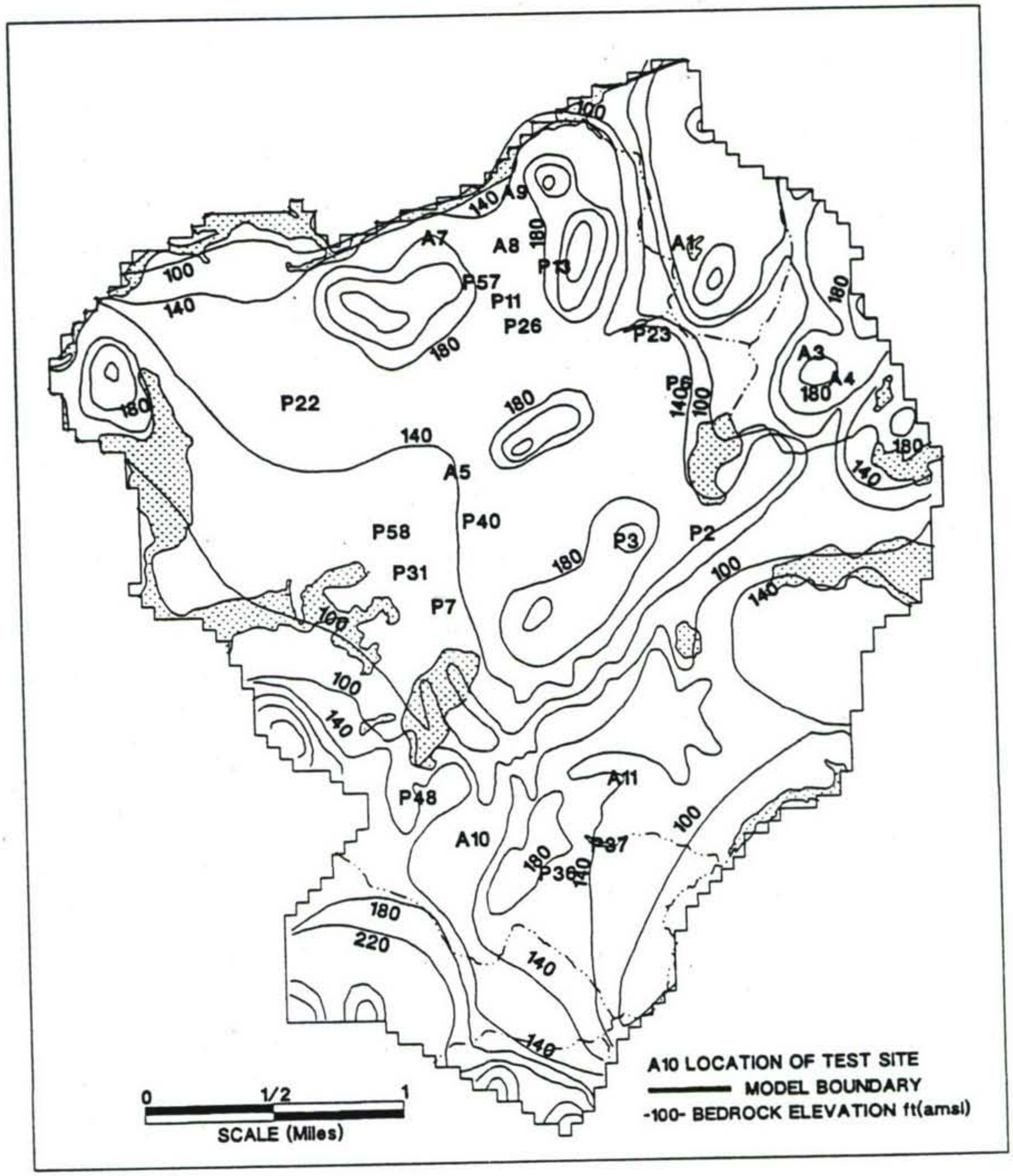
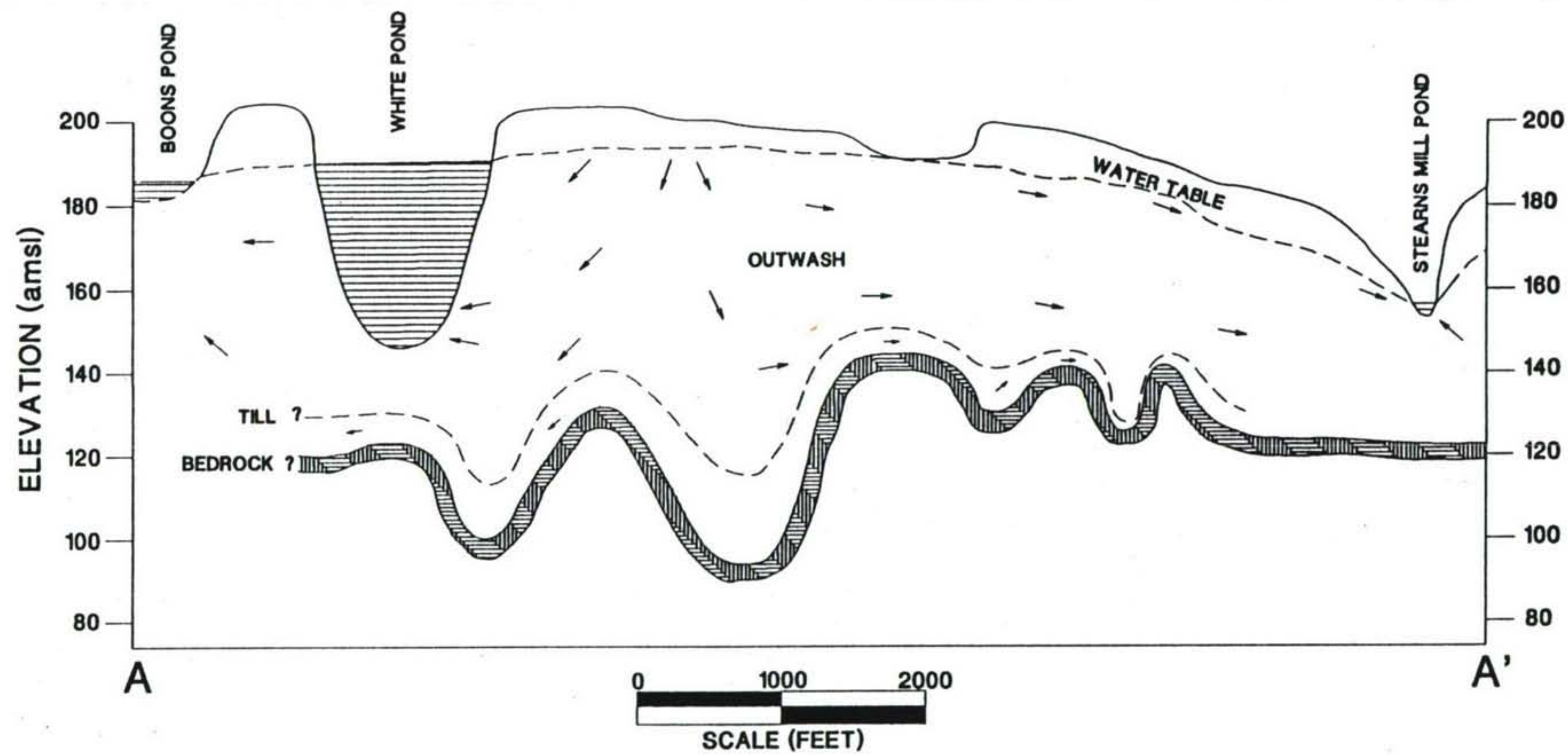


Figure 2.2 Location of slug test sites.

Table 2.1 Results of Slug Tests

AREA	WELL ID	TOTAL DEPTH (ft)	WATER ELEVATION (ft AMSL) (1/8/93)	HYDRAULIC CONDUC. (ft/min)
A1	DM2	15.04	186.6	0.0001
A1	DM3	14.67	188.45	0.007
A1	EHA5	21.88	180.3	
A1	SG-16		180.38	
A1	SG-17		179.6	
A3	OHM-A3-1	17.56	183.2	0.002
A3	OHM-A3-3	15.31	183.32	0.001
A3	EHA6	9.92	189.44	
A4	OHM-A4-4	15.62	196.41	
A4	OHM-A4-5	13.88	184.02	0.001
A4	DM4	16.38	188.88	0.0003
A4	DM5	19.48	195.96	0.0007
A4	EHA7	9.31	197.5	
A4	SG-13		182.6	
A5	OHM-A5-24	18.47	198.45	0.03
A7	OHM-A7-12	19.32	179.4	0.0003
A7	OHM-A7-13	14.84	229.25	
A7	OHM-A7-45	20.05	197.91	8E-05
A7	OHM-A7-46	10.3	203.85	
A7	EHA2	26.86	187.14	
A7	SG-6		176.95	
A8	OHM-A8-14	24.39	192.83	0.002
A8	OHM-A8-15	25.17	192.24	0.0004
A9	OHM-A9-16	70.62	193.54	0.02
A9	OHM-A9-17	58.62	184.85	0.0002
A10	OHM-A10-20	20.25	188.48	0.02
A10	DM1	19.37	188.63	0.05
A10	DM11	20.12	188.79	0.06
A11	OHM-A11-21	18.81	180.61	0.1
A11	OHM-A11-22	19.02	180.18	0.0001
A11	OHM-A11-23	20.21	186.19	0.02
A10	DM7	19.43	188.7	0.02
A11	SG-20		186.05	
P2	E3-P2-M01		189.57	0.0004
P3	E3-P3-M01		223.84	0.0011
P7	OHM-P7-30	16.49	192.84	0.07
P7	OHM-P7-31	15.11	193.43	0.02
P7	SG-1		193.33	
P11	OHM-P11-32	15.57	197.6	0.01
P11	OHM-P11-33	15.27	197.26	0.0006
P11	OHM-P11-34	18.14	196.16	0.001
P11	EHA3	26.93	193.34	
P11	SG-8		193.1	
P11	SG-18		197.15	
P13	E3-P13-M01		195.25	0.001275
P22	E3-P57-MO1		183.84	45.2
P26	E3-P26-M02		189.28	0.006009
P26	E3-P26-M03		188.98	0.0008296
P31	E3-P31-M01		185.11	0.00676
P36	EM-P36-MO		195.49	0.0001571
P36	EM-P36-M02		185.09	0.0001274
P36	EM-P36-M03		177.25	0.0008077
P37	EM-P37-M01		182.36	0.0002519
P37	EM-P37-M02		176.93	0.001938
P37	EM-P37-M03		175.15	0.005847
P40	OHM-P40-29	82.09	195.66	0.0008
P40	OHM-P40-38	16.69	196.45	0.04
P40	OHM-P40-39	20.77	196.57	0.006
P57	E3-P57-MO1			0.5
P58	E3-P58-M02		184.74	0.004985

Source: E&E(1994)



SOURCE: U.S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1539-E (Perlmutter, 1962)

Figure 2.3 Hydrogeological cross-section showing conceptual groundwater flow at Sudbury Annex.

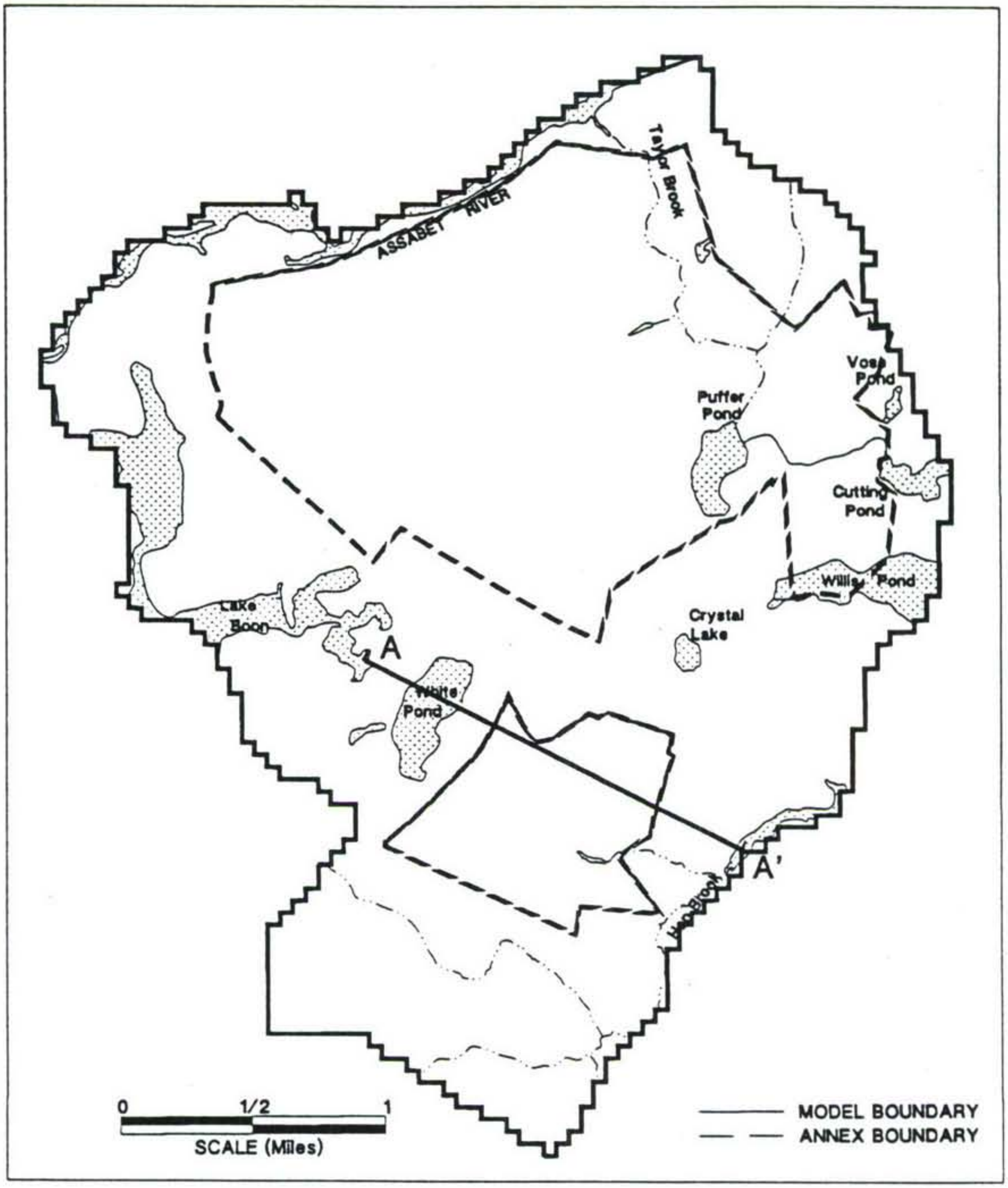
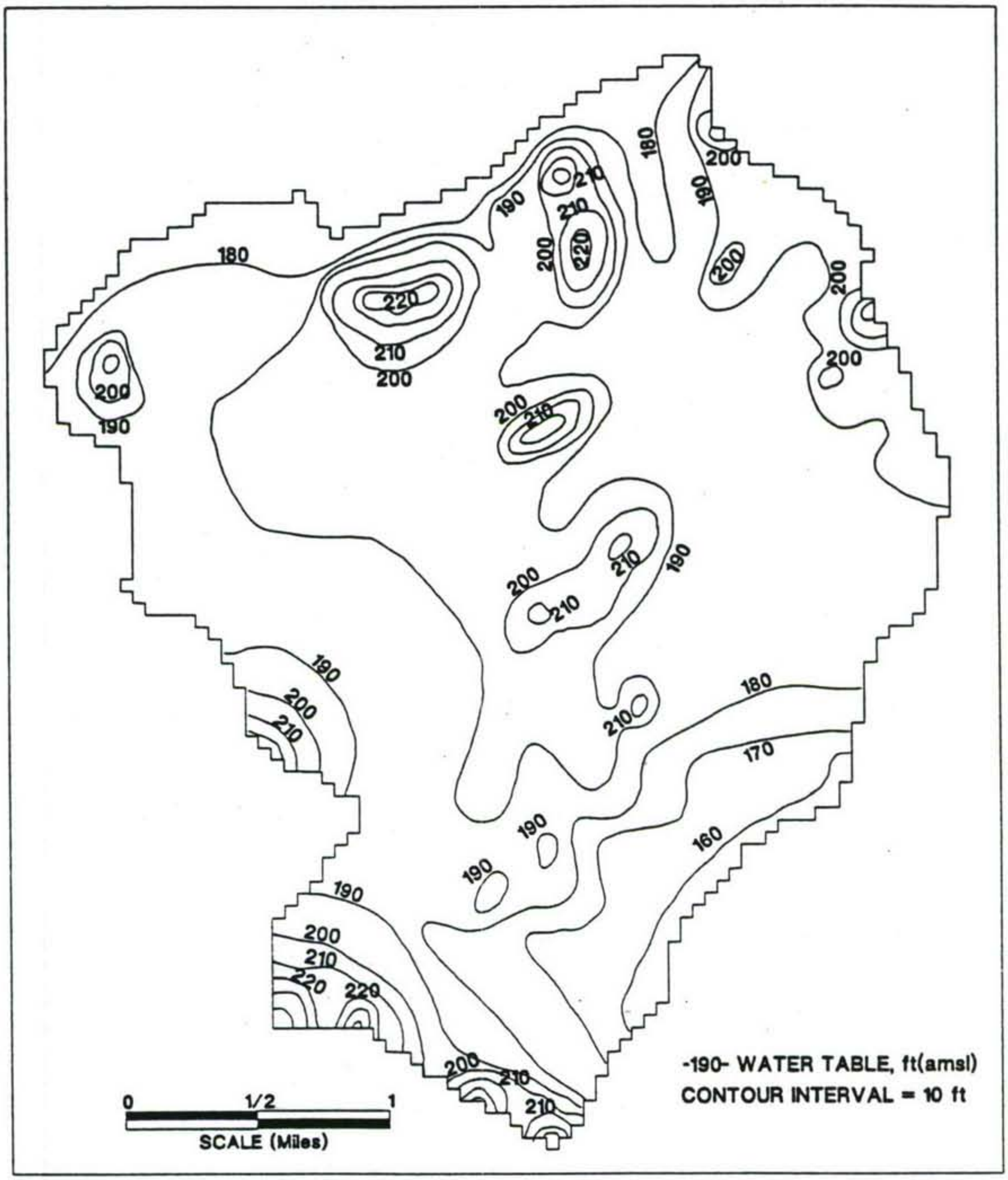


Figure 2.4 Base map showing location of cross-section.



INTERPRETED WATER TABLE

Figure 2.5 Interpreted average annual water table.

utilizing water level data from E&E (1994), and Perlmutter (1962). Where data gaps existed, the water table was obtained through the aid of USGS topographic maps and observations regarding typical depths to the top of the zone of saturation in both the hills and valleys at the site. The water table map henceforth shall be referred to as the interpreted water table in the remaining sections of this report.

The configuration of the water table surface indicates the existence of five major groundwater divides at the site. These correspond to the surface watersheds at the site. Figure 2.6 shows their locations and boundaries. The first watershed, Lower Taylor Brook, covers the northern section of the study site, and its main features are the hills in the northern border of the Annex and the marshes and streams in lower Taylor Brook valley. The discharge point of this watershed is the Assabet River. The second watershed, Upper Taylor Brook comprises Puffer, Cutting and Vose ponds, Vose hill and the swampy area in between them. Water flows from the wetlands east of Cutting Pond and from the vicinity of Vose Hill and eventually into Vose, Cutting and Puffer ponds. In the western part of this watershed, water flows from the hills into the tributaries of Taylor Brook. The Willis pond watershed, is located immediately south of Puffer and Cutting ponds and covers most of the area east of White Pond and north of Hop Brook Valley. Its major discharge locations are Willis Pond, Crystal Lake, and the marsh in between the two. The fourth watershed covers the southeastern portion of the study site. Its comprises the area east of Bruen Road and south of Crystal Lake. Water in the northern area of this watershed generally flows south and east towards the Hop Brook valley. In the southern portion, flow is towards the tributaries of Hop Brook. Lake Boon watershed, the last of the five, covers much of the western part of the site including White Pond. It borders along Bruen Road in the southeast and Sudbury Road in the north. The discharge locations of this watershed are Lake Boon, White Pond and the Assabet River in the northwest.

Pumping of water from surface water bodies and groundwater wells has been going on at the site for several decades. In the early 1950s, withdrawal of water by the Town of Maynard took place at White Pond, a water table pond, where daily withdrawals ranged from 420,000 to 450,000 gpd as reported by Perlmutter (1962). An additional 79,000 gpd were pumped from

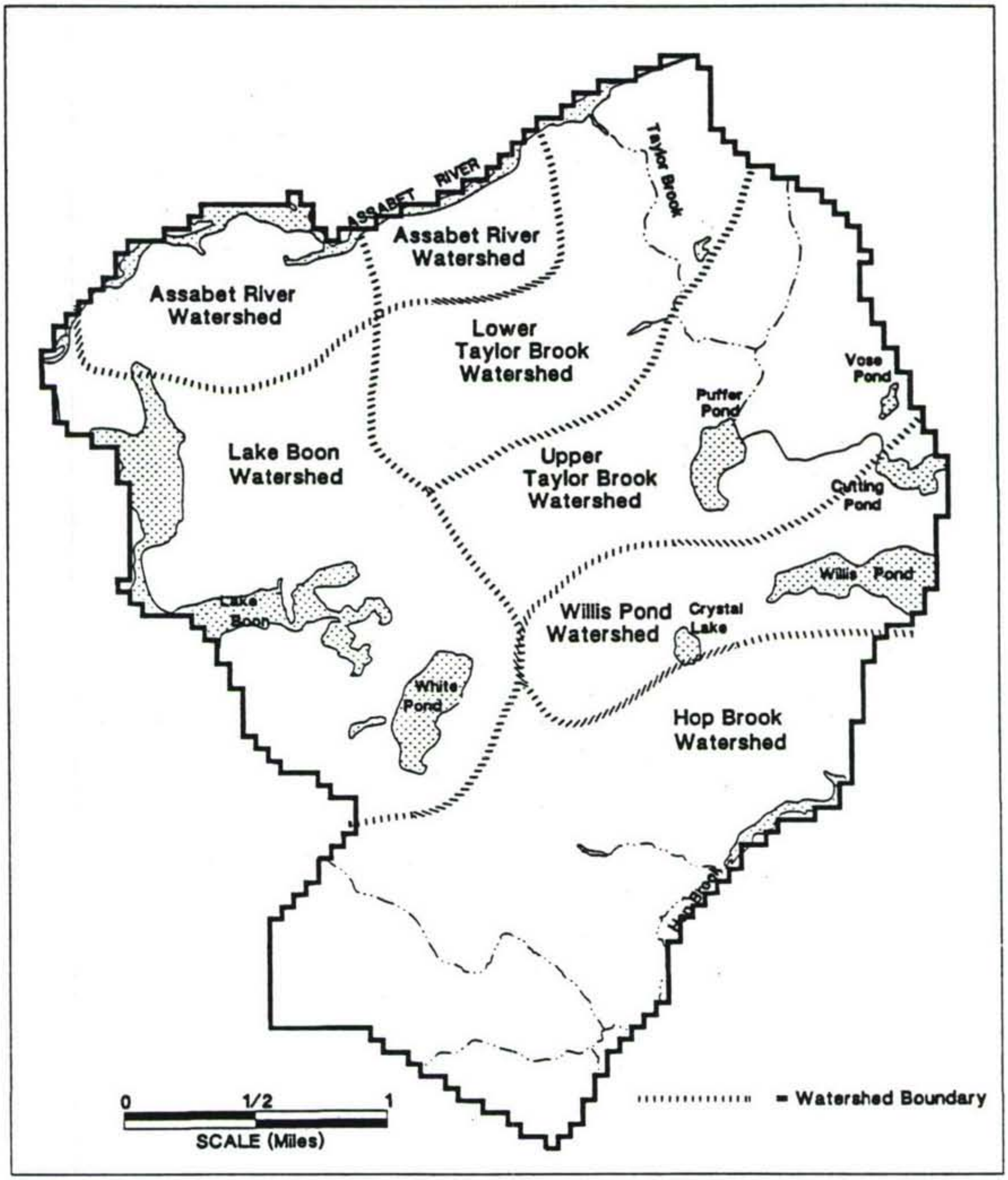


Figure 2.6 Watershed boundaries at Sudbury Annex and vicinity.

groundwater wells to supplement water demand for public supply, industry and agriculture. In 1993, withdrawal of water by pumping from White Pond was about a 100 million gallons, with monthly withdrawals ranging from 18 million gallons in July to 2 million gallons in January (Hussein Aldis, personal communication). This is down from the levels of pumping in the 1950s. Since White pond is hydraulically well connected with the underlying aquifer, the impact of present day pumping is directly reflected in its current stage of 186 feet (amsl).

3.0 GROUNDWATER FLOW MODELING

3.1 CONCEPTUAL MODEL

The conceptual model developed for the quantitative analysis of groundwater flow is illustrated in Figure 2.3. The hydrogeologic cycle consists of water entering the subsurface in the form of precipitation, recharging all three geologic units prior to discharging into the river, ponds and streams at the site. Direct precipitation onto natural and artificial ponds with large surface areas provide additional recharge to the system.

3.2 CODE SELECTION

The United States Geological Survey (USGS) three-dimensional groundwater flow code MODFLOW (McDonald and Harbaugh, 1988) was selected for use in this study because it is a well-accepted, public domain groundwater code. It has the capability to incorporate appropriate system features, is computationally efficient, and is relatively easy to use. MODFLOW is designed to simulate steady-state or transient groundwater flow through heterogeneous, anisotropic porous media in three dimensions subject to a variety of complex boundary conditions. The code, therefore, is quite versatile in that it can be used to simulate a wide variety of hydrogeological conditions that may exist in the field. There are, however, certain intrinsic limitations associated with MODFLOW. These limitations, primarily as they relate to the current work, are listed below:

- MODFLOW is designed to simulate groundwater flow in porous media; the code may not be used to explicitly model flow in individual fractures, faults, or solution cavities.

- The effects of density and/or temperature on the groundwater flow field are not considered. Therefore, in regions where the dissolved solids content of the groundwater is high enough to effect the pattern of groundwater flow, these concentration (density) effects are neglected.

- The aquifer material within individual grid cells is assumed to be homogeneous, and the grid is assumed to be aligned with the principal directions of hydraulic conductivity if the aquifer material is anisotropic.

- Stresses applied to a grid cell are assumed to be distributed uniformly over the cell face.

3.3 GRID DESIGN

The modeled domain is discretized in two dimensions by a rectangular grid with a uniform spacing of 250 feet in both directions (Figure 3.1). This level of detail was deemed sufficient to simulate flow through the principal aquifer, the glacial outwash. It also provides adequate resolution to outline the surface water features in sufficient detail. In regions where the bedrock outcrops, the hydraulic gradients are quite steep, and a finer grid resolution would be desirable. However, since the water table in the outcrop is not to be calibrated, and since the quantity of water flowing from the outcrop into the glacial outwash is independent of the level of grid size in the outcrop, any refinement of the grid in the outcrop regions was considered to be unproductive.

Vertically, the aquifer is divided into three layers in order to simulate flow in each of the three hydrogeologic units. Since the rate of vertical flow within the bedrock is negligible, the base of the model is arbitrarily set to a no-flow condition at a depth of 30 feet from the top of the bedrock unit. The lowest layer therefore has a uniform thickness of 30 feet, and the base elevation of the model in each cell is obtained by subtracting 30 feet from the top of the bedrock presented in Figure 2.1. A ten-foot thick till layer overlies the modeled bedrock unit. The actual thickness of the unit at the site varies from zero feet to several tens of feet. However, since, the till layer does not contain significant amount of groundwater, it was represented simplistically by a 10 feet thick uniform layer. Unlike the till and bedrock layers which were modeled as confined aquifers, the outwash represents an unconfined aquifer. For unconfined layers, MODFLOW requires specification of the bottom elevation of the modeled layer. The base of the outwash was obtained by adding 10 feet to the bedrock elevation throughout the

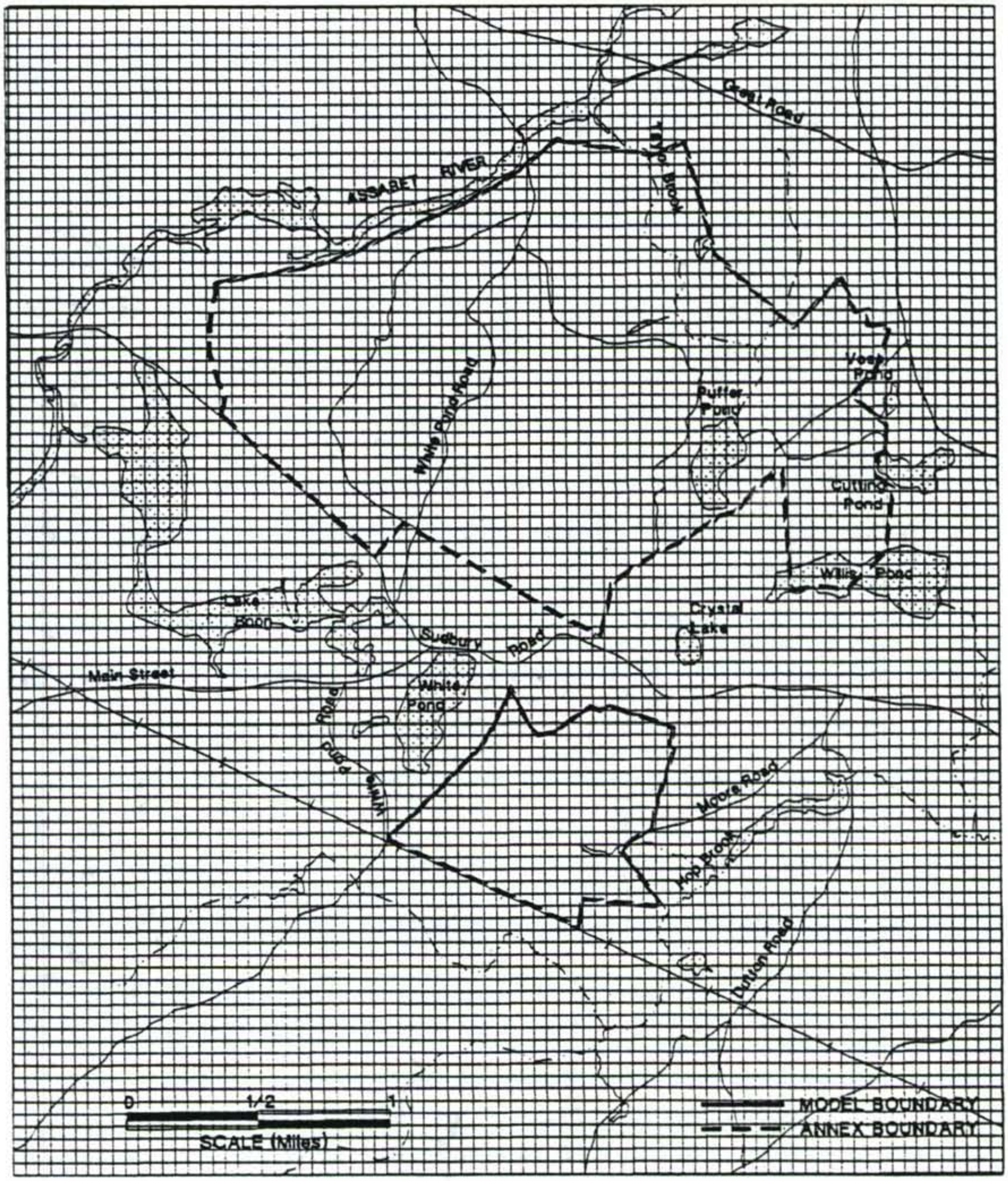


Figure 3.1 Regional model grid.

modeled domain except where the bedrock outcrops. In such regions, the modeled elements in all three layers represent the bedrock unit, and therefore the base of the topmost layer was set close to the base of the bedrock unit.

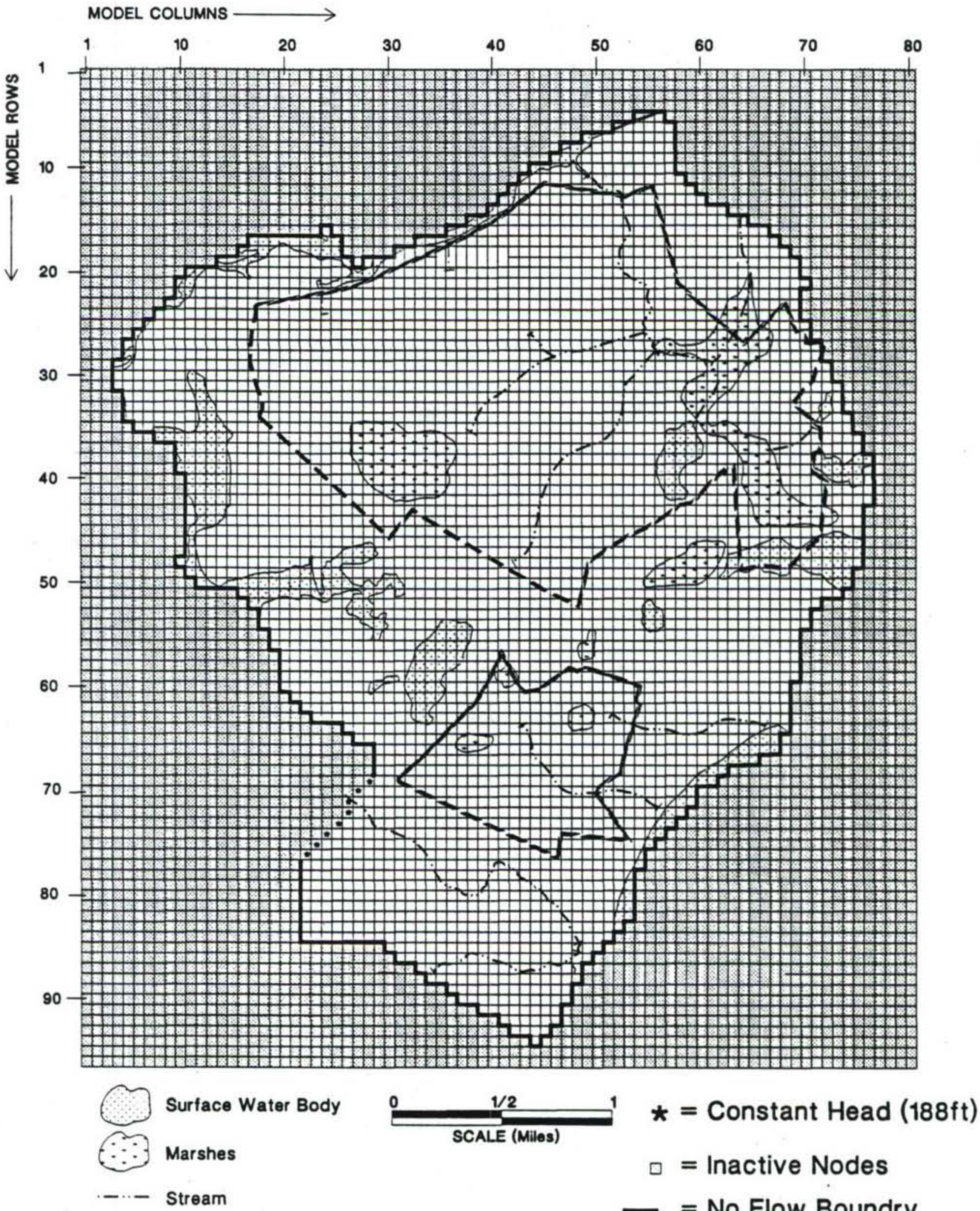
Each layer of the grid consists of 96 rows and 137 columns, giving a total of 7,680 nodes of which 4,133 nodes are active in each layer. The total number of nodes in all three layers is therefore 23,040, of which 12,399 nodes are active.

3.4 MODEL INPUT

3.4.1 Boundary Conditions

A combination of constant head, prescribed flux, and head-dependent flux boundary conditions were specified for the model. Appropriate consideration was given to maintain boundaries as close as possible to the site without interfering with the natural flow of surface and ground water within the domain. The areal delineation of the boundaries are shown in Figure 3.2. No-flow boundary condition is prescribed in all 3 layers along the Assabet River in the north and Hop Brook in the southeast. This ensures that groundwater discharges from the subsurface into the river and stream. No-flow condition is also prescribed along most of the remaining boundary through all three layers as it coincides with the groundwater divide in the area. The divides are formed either by the exposed bedrock or by discharging ponds. A series of constant head nodes are prescribed along the boundary southwest of White Pond. The boundary there lies within a marshy region where the exact direction of groundwater flow could not be determined. The prescribed constant head value there is 188 feet.

Since vertical flow within the bedrock is negligible, a no-flow boundary was prescribed along the base of the model. Along the top, recharge was specified in both the glacial outwash and bedrock outcrops. Hydraulic interaction between the surface water and groundwater was simulated through the RIVER package of MODFLOW. This is a head-dependent boundary condition, with the magnitude of the vertical flux between the two water bodies given by:


MODEL COLUMNS
MODEL ROWS
1
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50
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Surface Water Body
Marshes
Stream
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★ = Constant Head (188ft)
= Inactive Nodes
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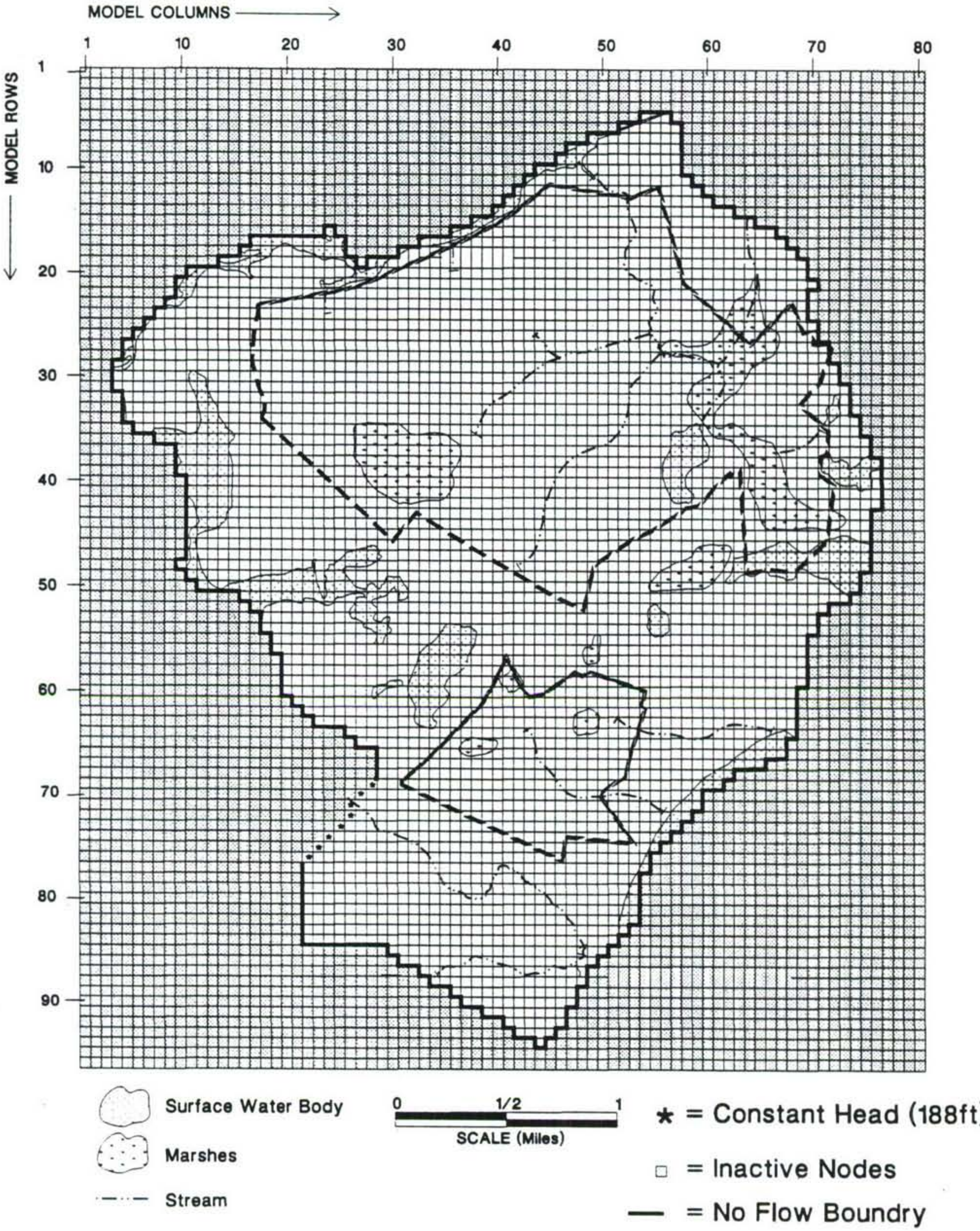

MODEL COLUMNS
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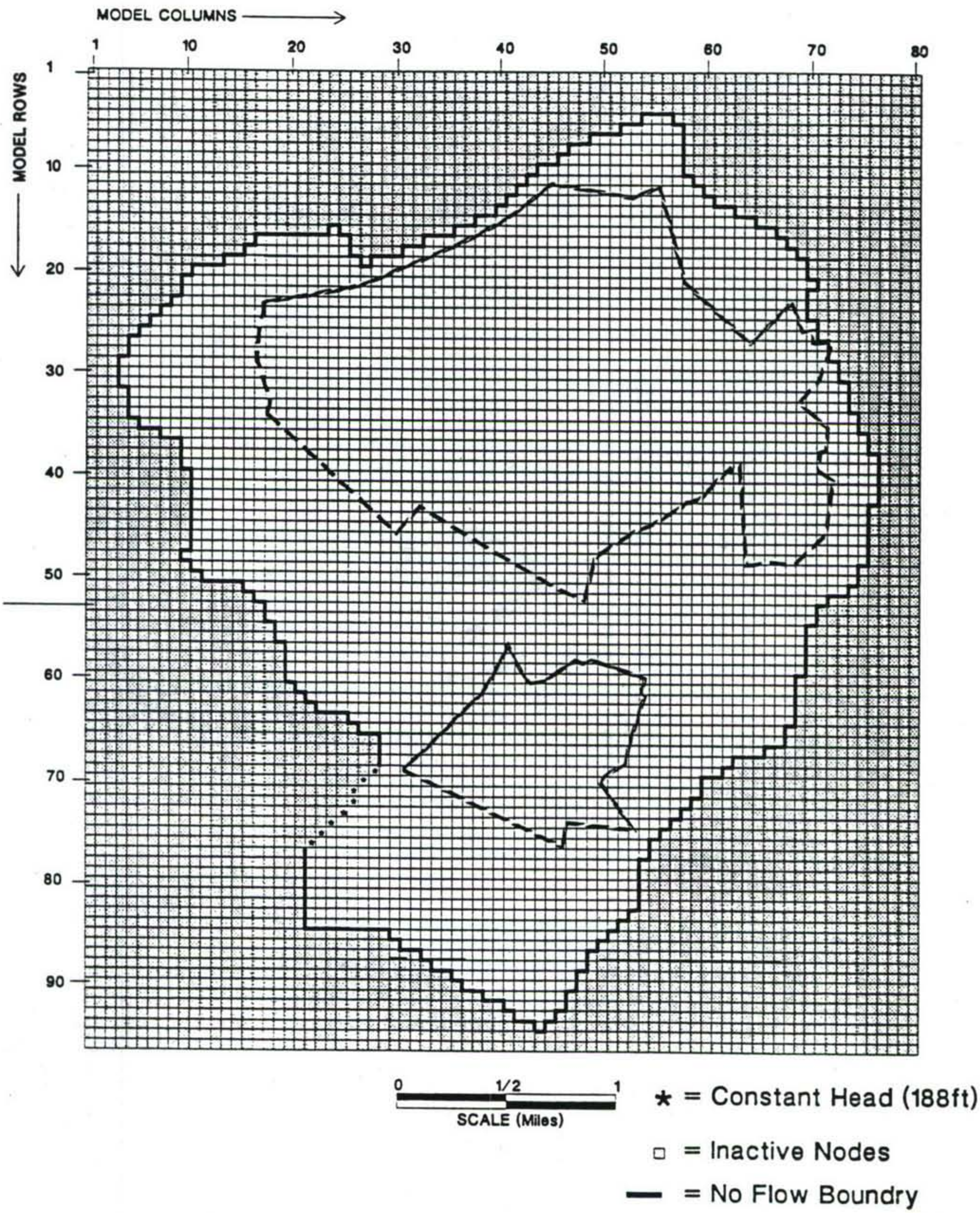

Figure 3.2 Model grid and associated boundary conditions.

$$q_v = CD\ (h_s - h_a)$$

where q_v is the vertical Darcy flux entering or exiting the aquifer, h_s is the prescribed stage of the surface water body, h_a is the simulated hydraulic head in the aquifer, and CD is the conductance of the river/pond bed. As further discussed in the following section, the conductance was set to a high value (99,999 sq ft/d) in order to ensure that the surface water stage nearly coincides with the water table elevation. The prescribed water levels of the surface water features were obtained from E&E (1994), Perlmutter (1962), and USGS topographic maps. These are presented in Figure 3.3. The Assabet River is dammed throughout the year at a fixed elevation of 176 feet. The stage in the other streams was assumed to drop approximately linearly from upstream to downstream.

Both ground and surface water are withdrawn from the site for various purposes since the early 1950s. Non-municipal groundwater withdrawal is mainly concentrated along the shores of Lake Boon. Some pumpage also occurs from domestic wells spread around the area. However, this is negligible compared to the municipal pumping of approximately one hundred million gallons per year from White Pond. Therefore, non-municipal pumpage was neglected in the calibration process, as its influence on the water table elevation was deemed insignificant. The effect of withdrawal from White Pond is represented by its current stage of 186 feet (amsl).

3.4.2 Hydrogeologic Parameters

The physical parameters input to the model were the hydraulic conductivities, vertical conductances between the aquifer units, and the hydraulic conductances of the river/pond beds. Initial estimates of the hydraulic conductivities were obtained from borehole test data discussed in Section 2.3. The horizontal conductivity in the outwash was estimated to range from 10 ft/d to 100 ft/d. The conductivity in the bedrock and the till was estimated to lie between 0.01 to 1 ft/d. The leakance between two adjacent units was estimated as the ratio of the average vertical conductivity of the units to their average saturated thickness. The vertical hydraulic conductivity was estimated to be one tenth the horizontal conductivity. The conductance of the

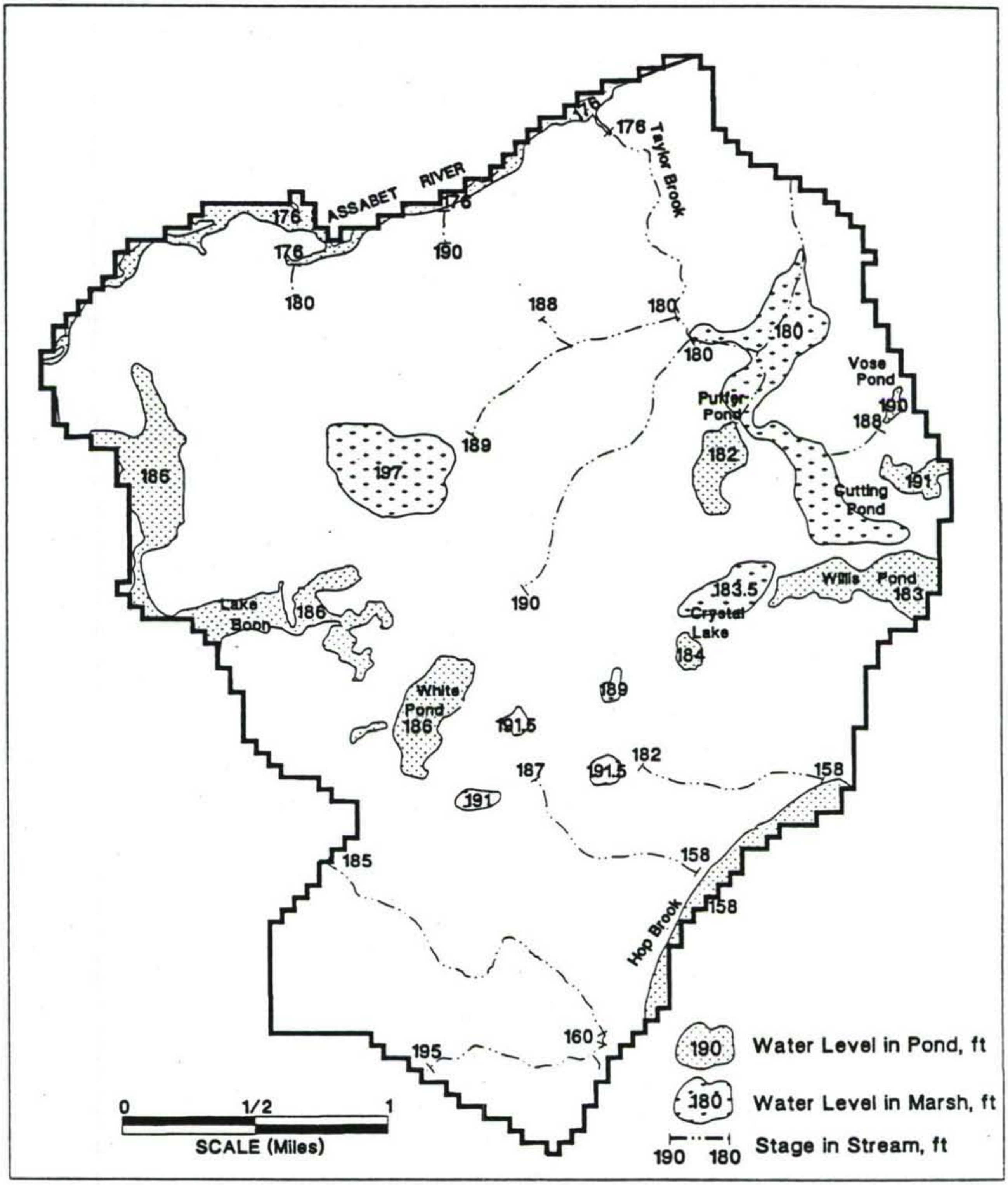

Figure 3.3 Surface water levels prescribed to river package of MODFLOW.

river and ponds was obtained by noting that the hydraulic elevations in the surface bodies at the site coincide with the top of the saturated zone (Perlmutter 1962). Therefore, the conductance of the river and pond beds was arbitrarily set to a high value (99,999 sq. ft/d) in order to ensure that surface water bodies are hydraulically in full contact with groundwater throughout the modeled domain.

3.5 MODEL CALIBRATION

3.5.1 Overview & Targets

The groundwater flow dynamics at the site is hydrogeologically complex but conceptually simple. Water enters the subsurface in the form of precipitation flowing towards drainage areas formed by numerous streams, ponds, and marshes. The modeled domain therefore consists of several watershed regions. The process of calibration, hence, involves determining the appropriate rate of infiltration into the system, and the hydrogeologic permeabilities of the different subsurface layers in order to obtain a water table configuration representative of the site.

The primary objective of this study is to develop a groundwater flow model capable of assisting in hydrogeologic investigations for the purpose of studying the long-term cumulative impacts of continuous pumping of water and the migration of potential contaminants in and around the site. For such a time scale, a steady-state rather than a transient model suffices, especially since the seasonal fluctuations of the water table at the site is quite low (Perlmutter, 1962), and no appreciable long-term variations have been noted (Hussein Aldis, personal communication). The calibration target for this model is therefore the long-term annual average water table discussed in Section 2.3 and presented in Figure 2.5.

Another calibration target is the amount of groundwater discharging into White Pond, a major source of water for the Town of Maynard. Approximately 100 million gallons is pumped annually from White Pond. Since White Pond is only about 40 acres and it loses approximately

35 million gallons per year from evapotranspiration while receiving perhaps 45 million gallons per year from precipitation (Hussein Aldis, personal communication), the remaining 90 million gallons per year must be accounted for by groundwater discharge into White Pond. Therefore, the calibrated groundwater model was expected to account for approximately 90 million gallons per year discharge into White Pond.

3.5.2 Calibration Process

The process of calibration involved adjusting the model parameters in order to minimize the difference between the interpreted and simulated water table elevations. The calibration parameters were primarily the hydraulic conductivities of the hydrogeologic units and the recharge/discharge to the groundwater system. The river/pond stage and the bedrock elevation were initially adjusted slightly in order to maintain conformity with the conceptual model. Initial estimates of the conductivities and recharge were obtained from Perlmutter (1962), and E&E (1994). Numerous simulations were then conducted in order to obtain a simulated water table surface that was in close agreement with the interpreted water table. The model was then considered calibrated, and a reliable predictive tool for remediation and environmental impact assessments.

3.6 RESULTS

The calibrated water table is shown in Figure 3.4. For comparison, it is superimposed on top of the interpreted water table in Figure 3.5. In general, the difference between the interpreted and simulated heads are less than 2 feet in the outwash. In the bedrock outcrop, the differences in water levels is relatively larger. It should be noted, however, that the water levels in the outcrops are mainly based on interpretation of the topography, and since the hydraulic gradients are very steep, a slight misplacement of a contour line on the observed map, or a small shift in the simulated hydraulic values, may easily cause large discrepancies. Furthermore, and more importantly, it should be realized that simulated water levels in the outwash, which are of primary interest in this study, are not affected by the head distribution in the outcrop and only

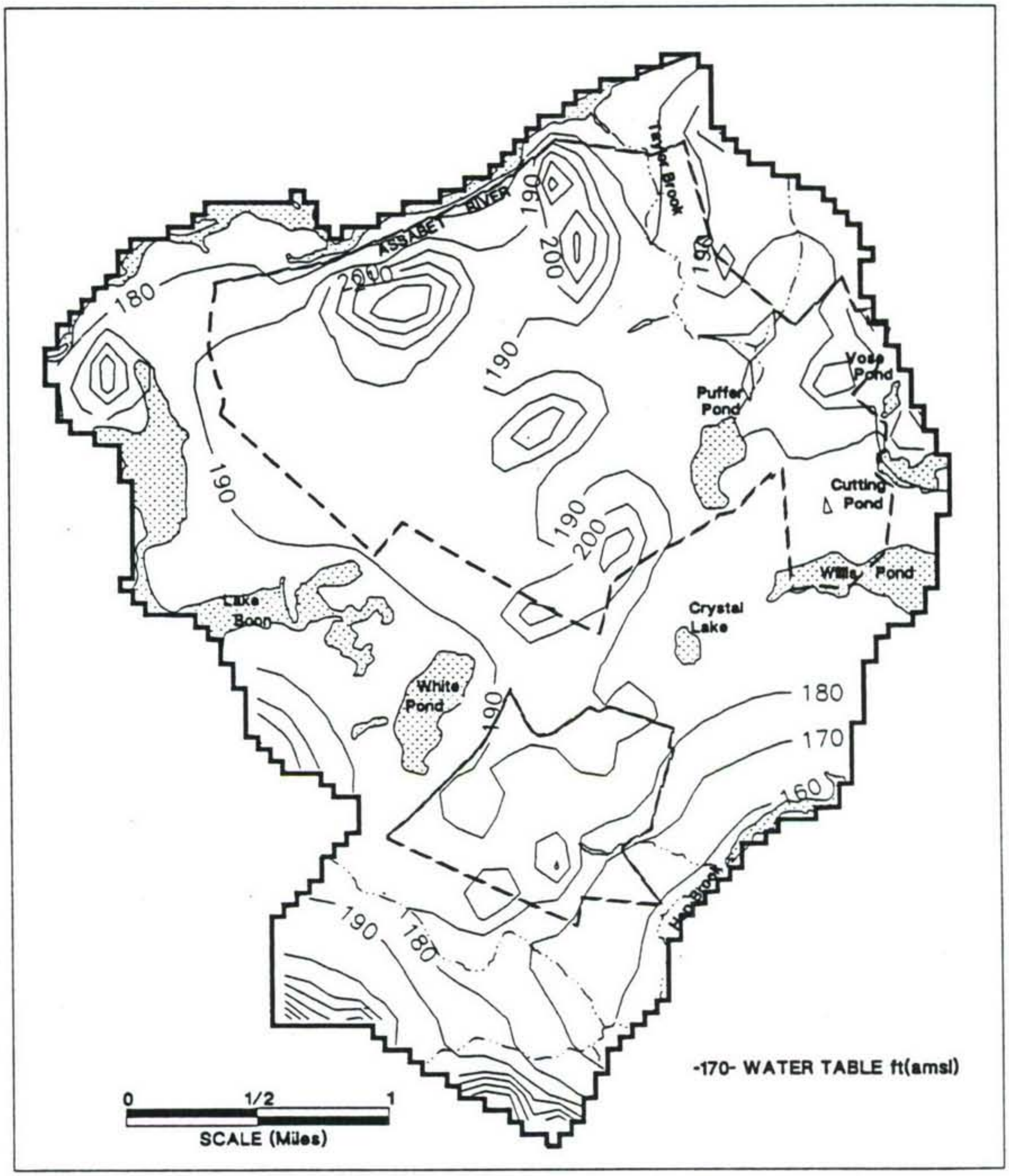

Figure 3.4 Calibrated water table.

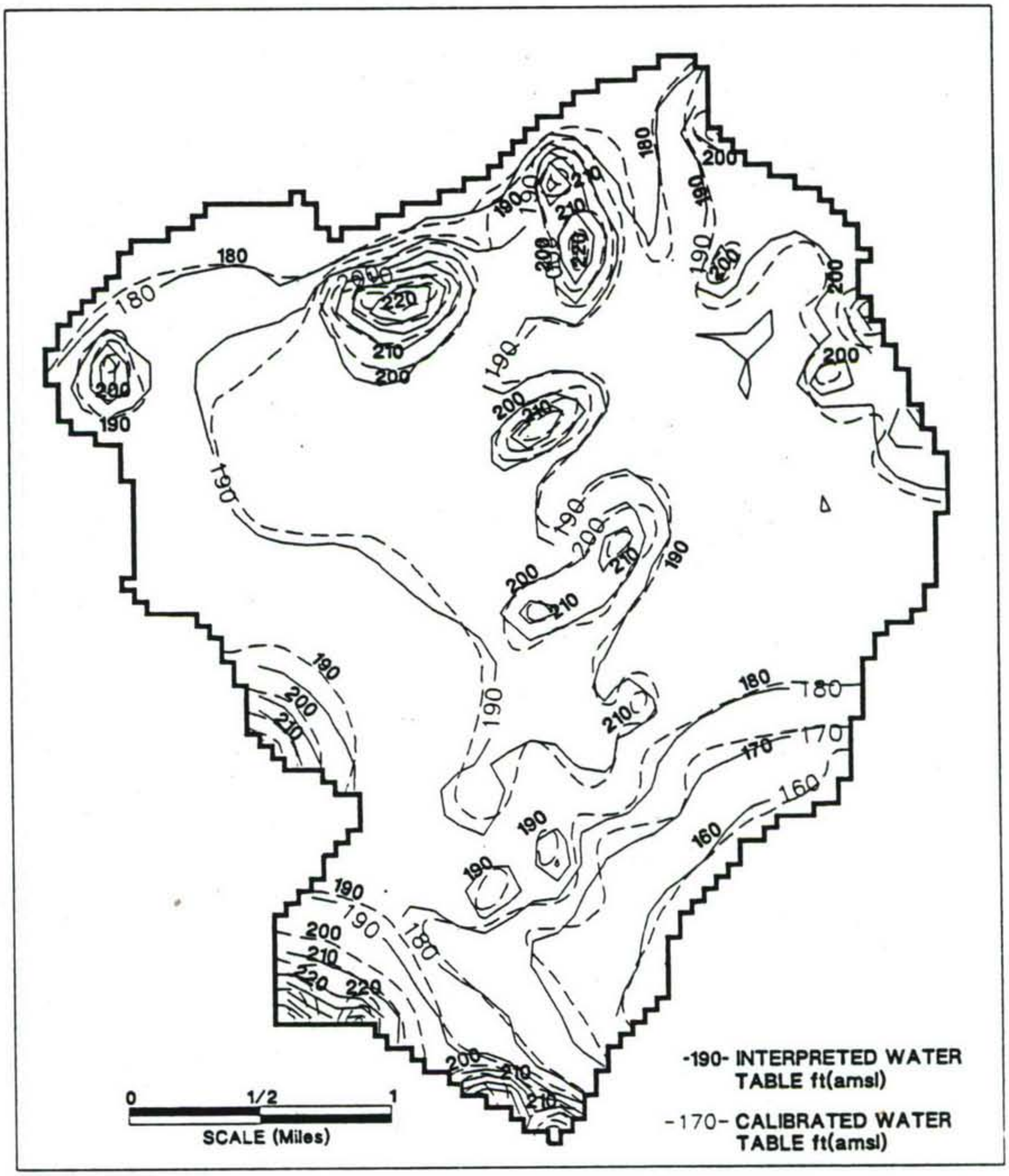

Figure 3.5 Comparison of calibrated and interpreted water levels.

depend on the rate of recharge in the outcrops.

The hydraulic heads within the modeled till and bedrock units, the lower two units, are presented in Figures 3.6 and 3.7. As expected, they mimic the water table since flow within all geologic units has to conform with the regional watershed configuration. However, since the rate of flow between the outwash and the lower units is negligible, water table profile is determined almost entirely by areal flow within the glacial outwash. Therefore, for all practical purposes the lower two layers may be neglected for modeling the water table surface.

The calibrated recharge distribution in the domain is presented in Figure 3.8. A uniform 20 inches per year recharge was applied over the glacial outwash. This is close to the 22 inches per year average suggested by Perlmutter (1962). A decreased recharge of 10 to 15 inches per year was applied over the outcrops in order to emphasize the probability of increased runoff. The effect of recharge in the river and other surface water bodies including marshes was directly incorporated by the stage prescribed to the MODFLOW river package as shown earlier in Figure 3.3.

The calibrated hydraulic conductivities in the lower units which represent the bedrock and till layers are 0.1 and 1.0 respectively. As discussed earlier, the model is insensitive to these parameters. The calibrated horizontal hydraulic conductivity in the top layer, which represents the glacial outwash in most of the domain except where the bedrock outcrops, is presented in Figure 3.9. The conductivity ranges from 10-90 ft/d in the outwash. This is consistent with the range obtained from borehole tests discussed in Section 2.3. In the outcrops, the calibrated conductivity ranges from 0.01 to 1 ft/d.

Since MODFLOW is a quasi three-dimensional code, the vertical component of flow is accounted for by leakance between the modeled layers. The calibrated leakance between the outwash and till units was 0.05, and 0.003 between the till and bedrock. As expected, the model was insensitive to this parameter.

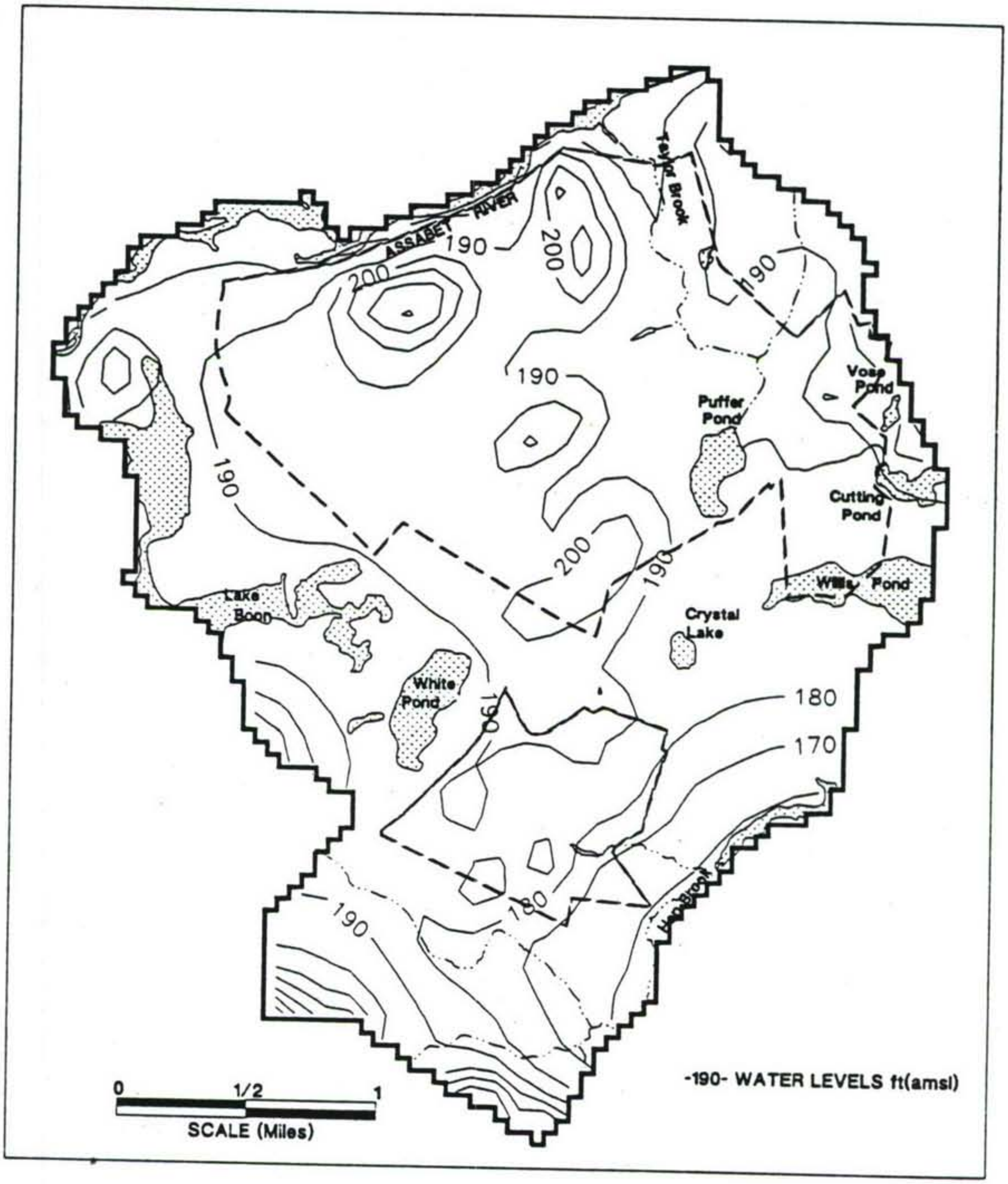

Figure 3.6 Water levels in middle modeled layer which represents the till unit.

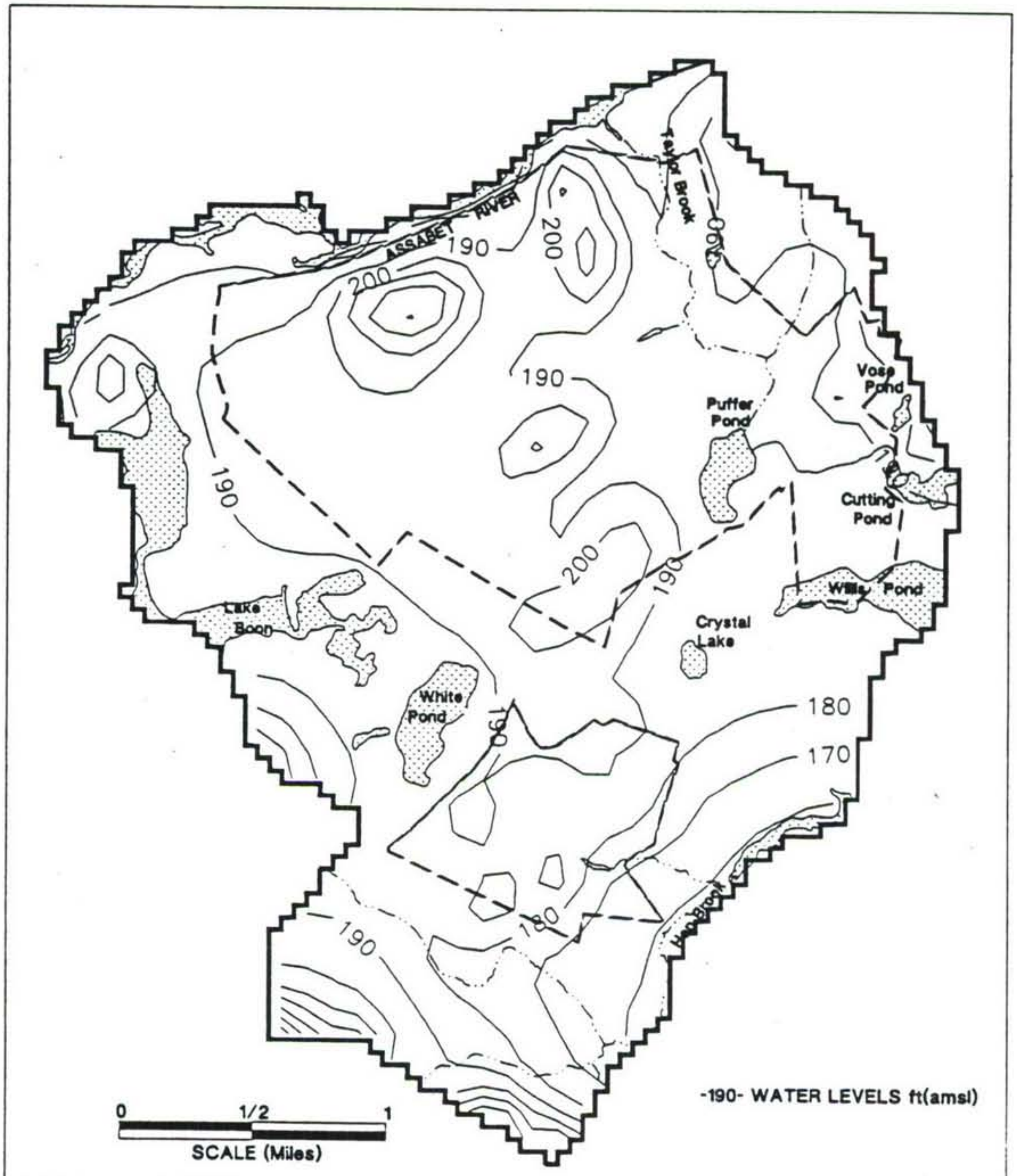

Figure 3.7 Water levels in lowermost modeled layer which represents the bedrock unit.

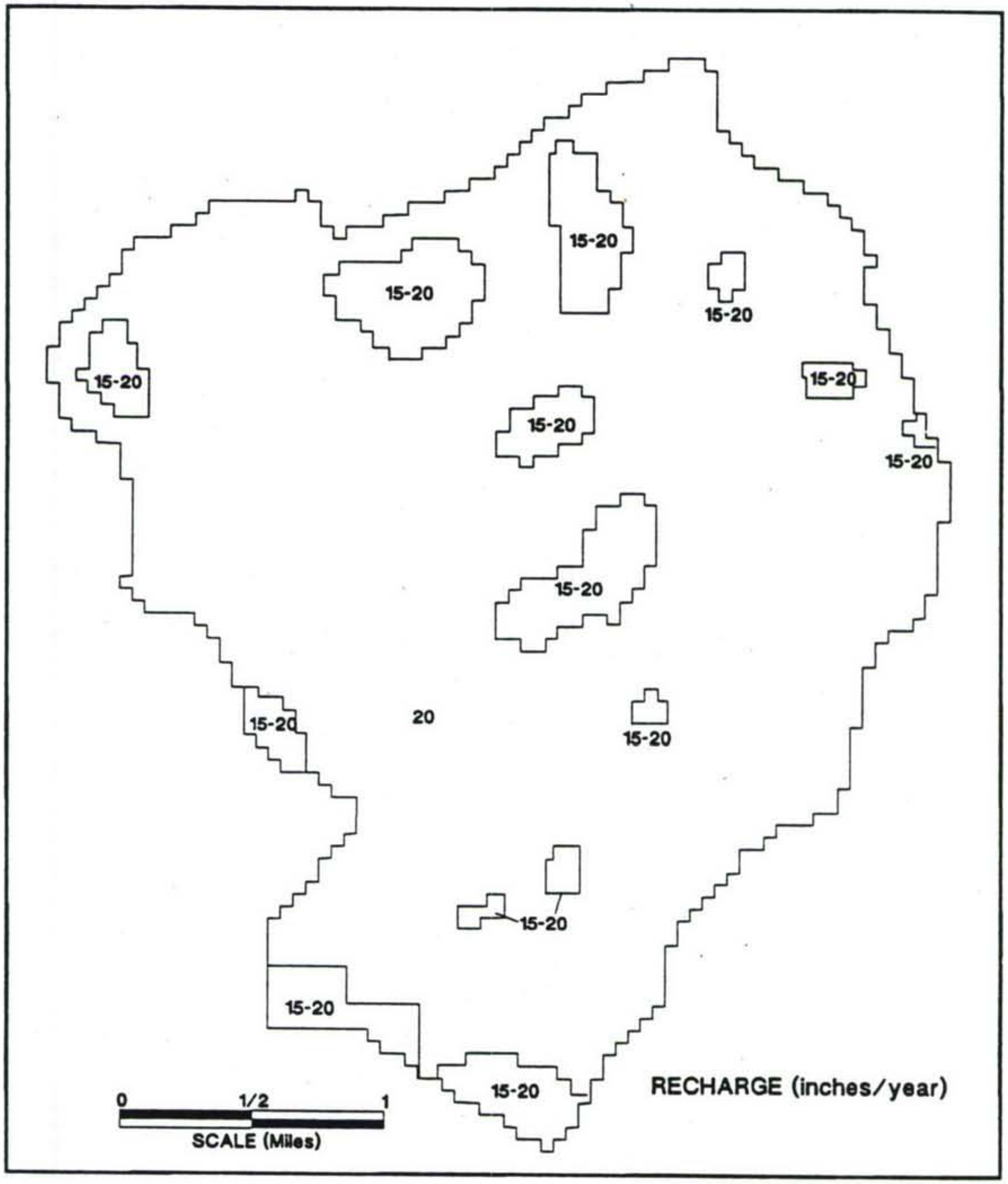

Figure 3.8 Calibrated areal recharge.

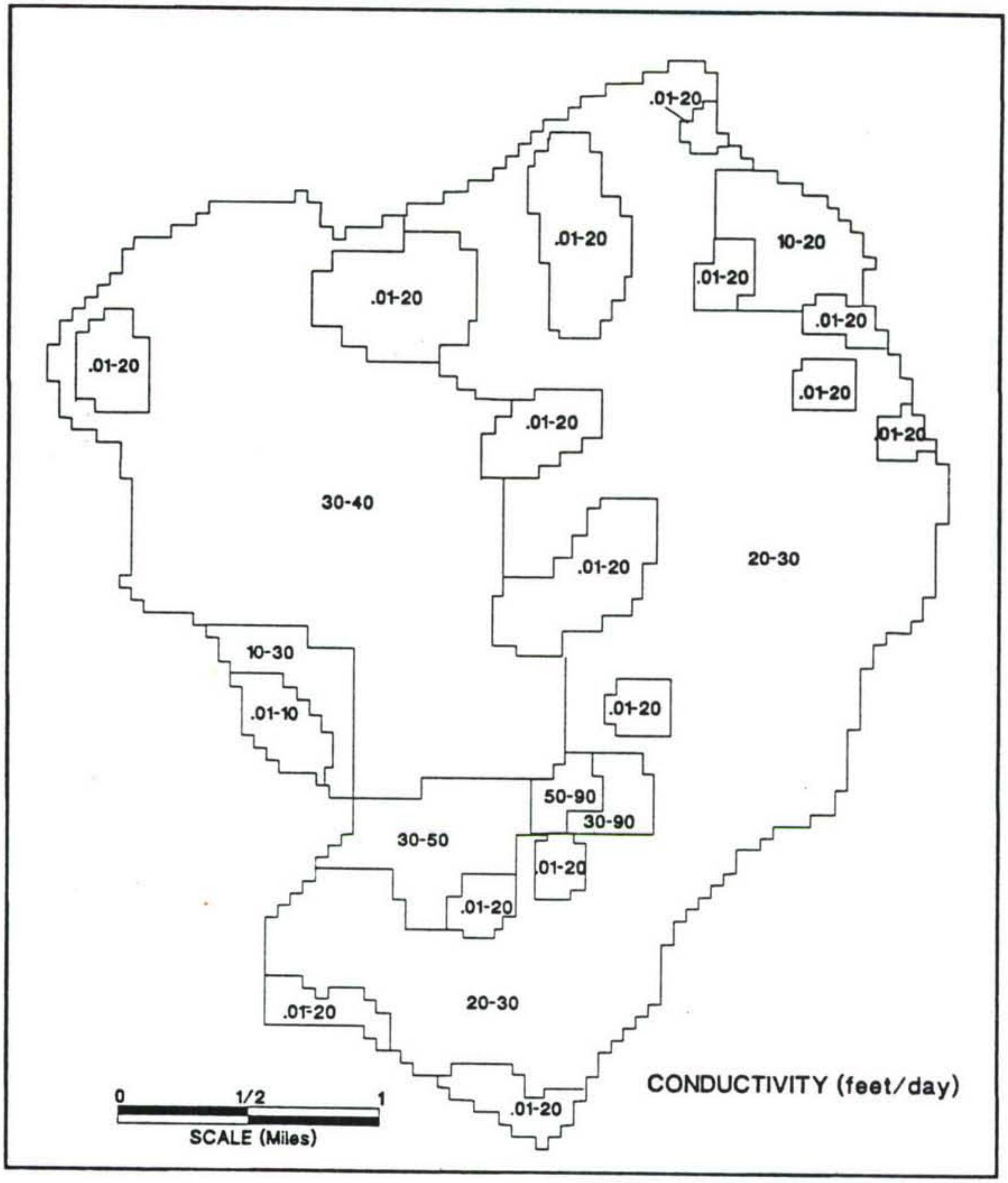

Figure 3.9 Calibrated horizontal hydraulic conductivities in topmost modeled layer.

The Darcy velocity vectors in the topmost modeled unit are presented in Figure 3.10. Flow emanates from the outcrops, traversing through the outwash prior to discharging into the ponds and streams. Due to the steep slopes, the rate of flow is approximately an order of magnitude larger in the outcrops than in the outwash. In order to emphasize the subsurface watersheds in the modeled domain, a logarithmic scale velocity plot for the topmost layer is presented in Figure 3.11. The existence of watersheds discussed in Section 2.3 are clearly evident in this plot. In order to demonstrate the utility of the model as a tool for remedial investigations, the entire travel path for particles released at several locations at the site is shown in Figure 3.12. The particle tracks reveal the complex hydrogeologic flow patterns existing at the site. Contaminants infiltrating the subsurface at close proximity eventually travel in entirely opposite directions.

The total simulated groundwater discharge into White Pond is 108.3 million gallons per year (mgy). This is approximately 8 percent greater than the estimated 100 mgy municipal withdrawal by the Town of Maynard, and about 20 percent higher than the calibration target of 90 mgy. This suggests that if the withdrawal and evapotranspiration rates for White Pond are reliable, then either recharge in the Lake Boon watershed near White Pond is approximately 20 percent less than the calibrated case, or the southeastern boundary of the watershed is slightly westward of that suggested by the model. A slightly higher water level in Lake Boon and White Pond can cause a westward shift of the watershed.

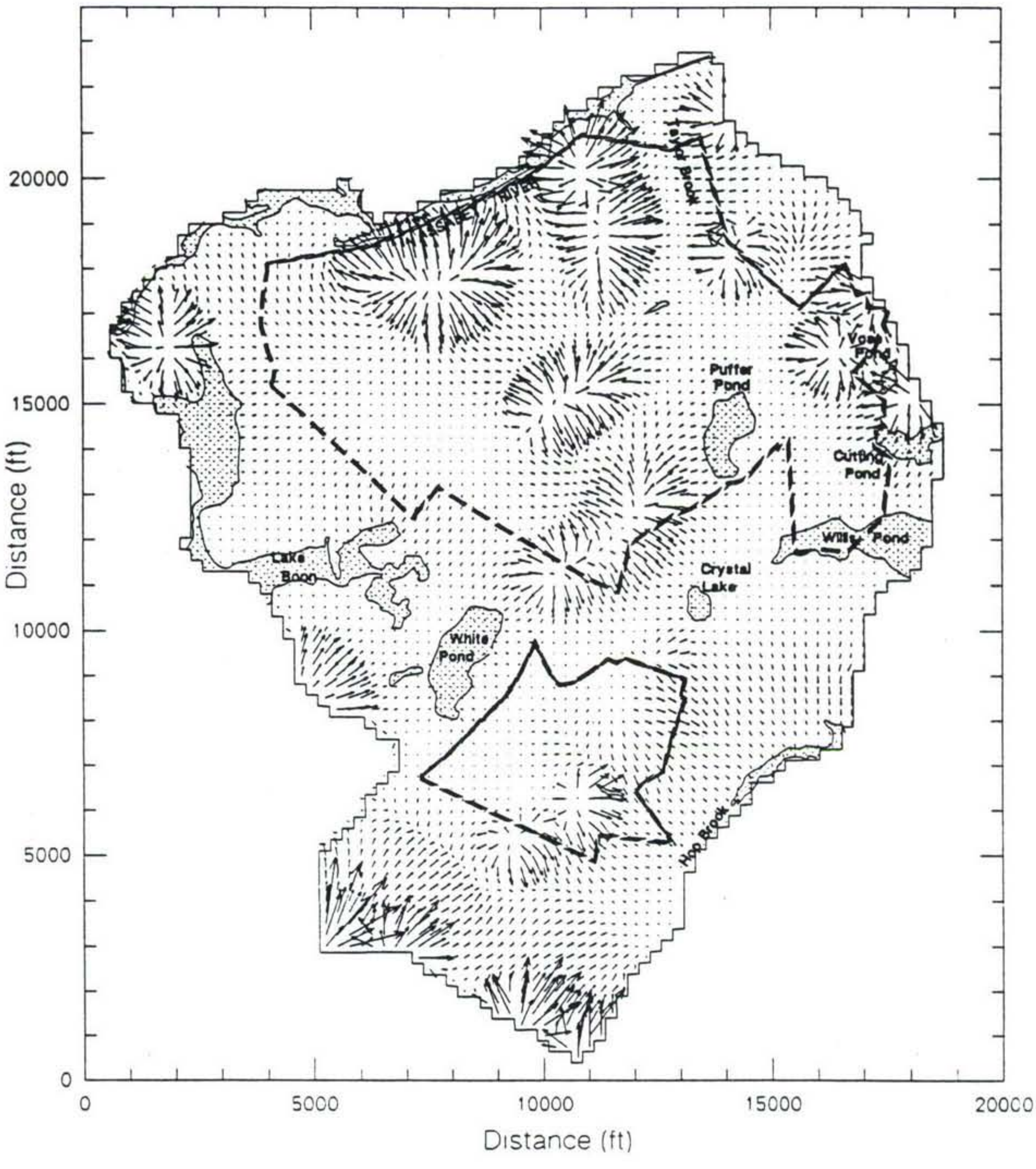

Figure 3.10 Darcy velocity vectors in topmost modeled layer. The length of the vector arrow is proportional to magnitude of velocity.

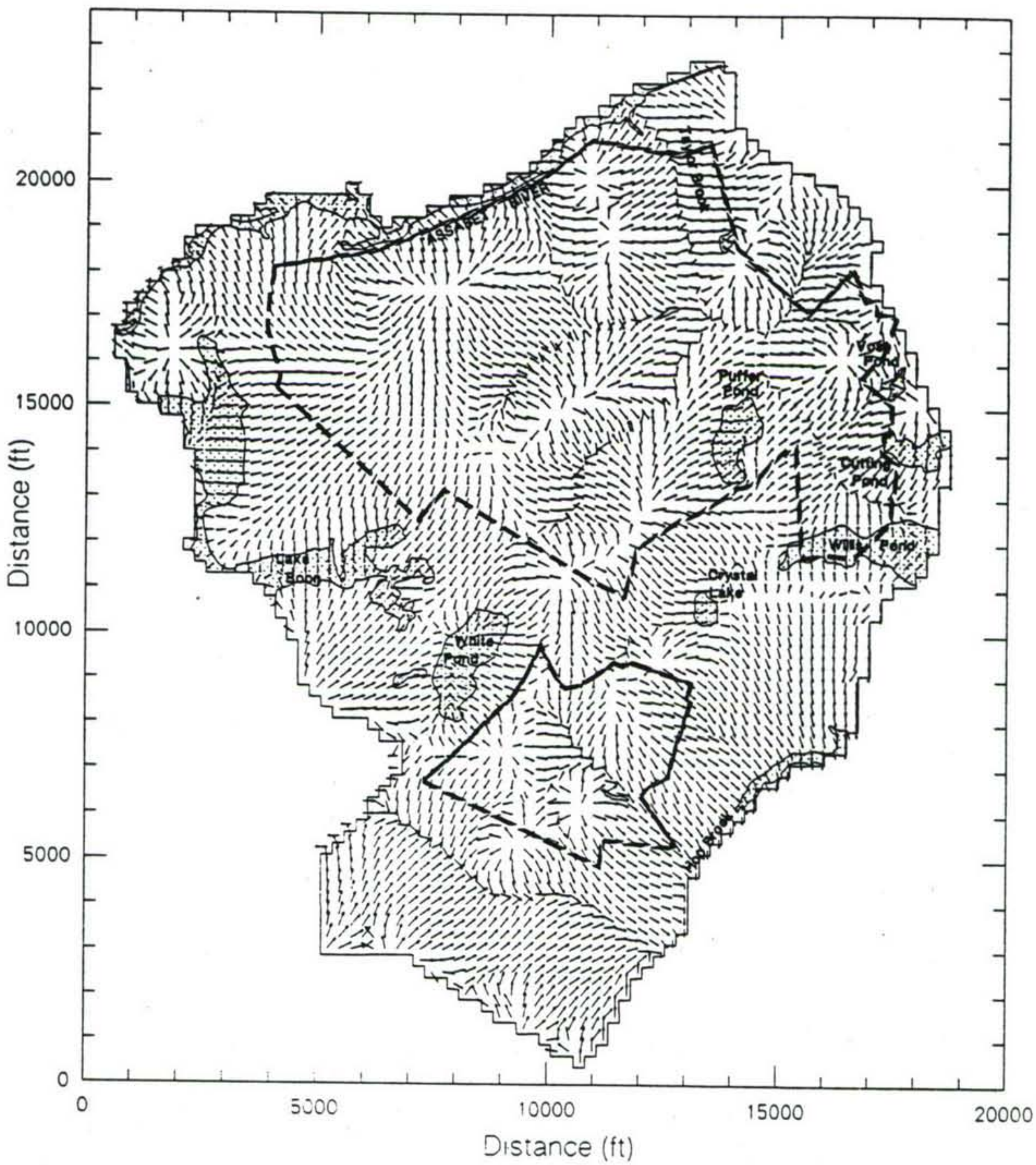

Figure 3.11 Log normalized Darcy velocity vectors in topmost modeled layer. Length of vector arrow is proportional to the logarithm of the magnitude of the velocity.

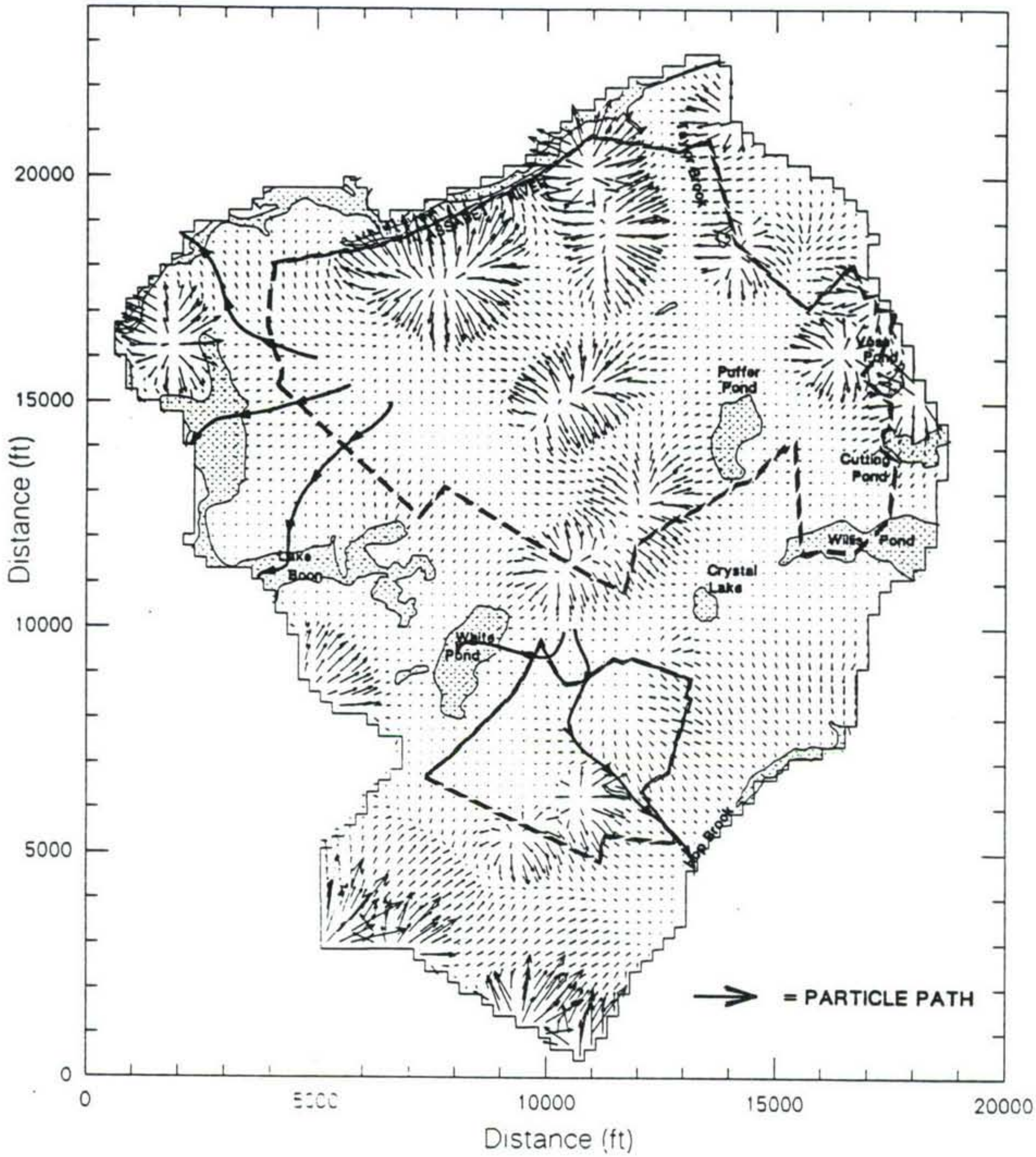

Figure 3.12 Example of particle travel paths in groundwater.

Streamflow rates within the modeled domain are reported for Marlboro Brook and Unnamed Brook by Perlmutter (1962). The locations of the gauging stations are shown in Figure 3.13. The measured daily mean discharge at the gauging stations is presented in Tables 3.1 and Table 3.2. The average monthly discharge at the Marlboro Brook gauging station varies from a low of 0.18 cubic feet per second (cfs) in July 1955 to a high of 1.3 cfs in April 1956. The average daily discharge for the 15 month period from April 1955 to June 1956 if 0.61 cfs. The model simulated discharge at the same location is 0.71 cfs. Measured discharge at the gauging station in Unnamed Brook varies from 0.07 cfs on August 15, 1955, to 0.22 cfs on May 9, 1955. The average daily discharge for the 7 days when measurements were taken in 1955 was 0.14 cfs. The model simulated daily discharge at the same location in Unnamed Brook is 0.13 cfs. The simulated discharge at both the locations compares well with the measured discharge, and is further indication of a well calibrated model.

The overall budget for the entire model is shown below:

	Cumulative Volume (ft^3)	
	IN	OUT
Storage	0.0	0.0
Constant Head	2977.0	9271.8
Wells	8.47E+05	0.0
River Leakage	2.85E+07	2.92E+07
Total	2.94E+07	2.93E+07

Percent Discrepancy = 0.43

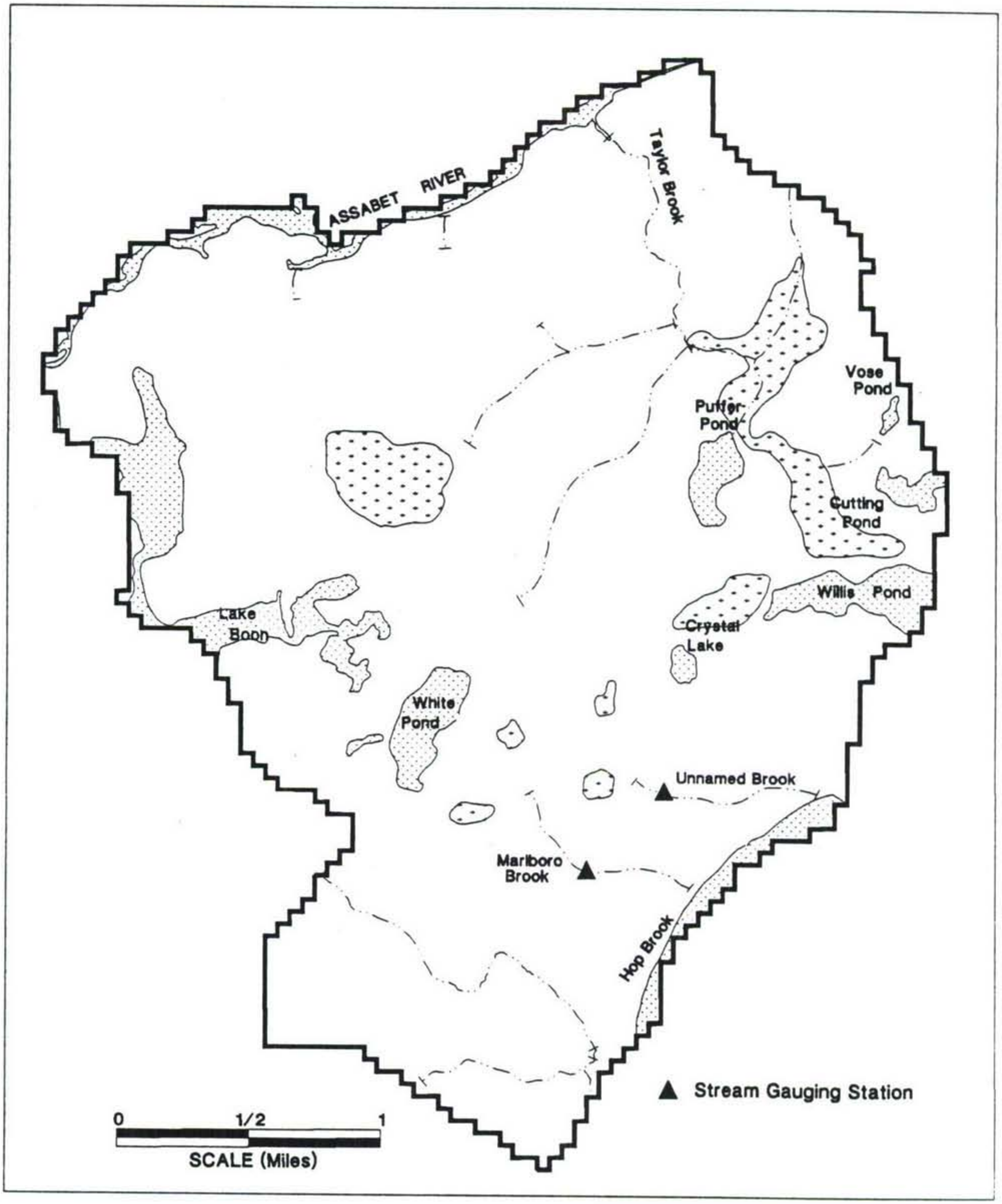

Figure 3.13 Location of gauging stations within modeled domain.

Daily mean discharge, in cubic feet per second, of Marlboro Brook, Maynard Ordnance Test Station, Massachusetts, for the period April 23, 1955, to June 30, 1956

Day	1955									1956					
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1	----	0.66	0.43	0.19	0.14	[1]0.75	[1]0.50	0.78	0.54	[1]0.31	0.52	0.52	0.69	1.10	0.88
2	----	.60	.36	.26	.13	[1].68	[1].49	.68	.54	[1].31	.55	.56	.80	1.02	.75
3	----	.56	.32	.30	.13	[1].64	[1].48	.61	.54	[1].31	.54	.70	.86	.98	.83
4	----	.54	.31	.21	.13	[1].60	[1].47	.98	.66	[1].31	.52	.91	1.03	.95	.88
5	----	.54	.30	.19	.12	[1].56	[1].46	2.21	.77	[1].30	.48	.81	1.51	.91	.73
6	----	.57	.28	.22	.12	[1].54	[1].58	1.44	.61	[1].30	.47	.71	1.77	.90	.67
7	----	.54	.29	.25	.15	[1].52	[1].80	1.12	.56	[1].30	.70	1.08	1.65	.88	.58
8	----	.55	.28	.20	.15	[1].50	[1].60	.97	.52	[1].30	.61	1.12	1.40	.83	.52
9	----	.52	.28	.18	.13	[1].48	[1].50	.88	.51	[1].30	.60	.91	1.39	.79	.52
10	----	.47	.36	.20	.13	[1].46	[1].44	.83	.50	[1].31	.60	.79	1.50	.78	.52
11	----	.46	.25	.19	.14	.45	[1].40	1.36	.47	[1].32	.59	.79	1.64	.78	.50
12	----	.44	.62	.17	.19	[1].44	[1].36	1.10	.46	[1].36	.91	.78	1.64	.79	.47
13	----	.42	.46	.17	.26	[1].43	[1].35	.91	.44	[1].41	.79	.78	1.59	.76	.58
14	----	.42	.34	.16	.23	[1].43	[1].35	1.20	.42	[1].47	.71	.78	1.47	.75	.68
15	----	.41	.29	.16	.16	[1].42	1.12	1.04	.42	[1].50	.74	.76	1.41	.73	.50
16	----	.39	.28	.25	.15	[1].42	1.31	.95	.41	[1].53	.73	.73	1.75	.71	.72
17	----	.38	.26	.21	.15	[1].41	1.44	.91	.41	[1].56	.66	.71	1.74	.68	.63
18	----	.37	.23	.18	.72	[1].41	1.00	.84	.40	[1].58	.63	.68	1.44	.67	.50
19	----	.36	.22	.18	7.04	[1].41	.81	.76	[1].39	[1].60	.60	.66	1.31	.66	.45
20	----	.35	.25	.16	[1]2.50	[1].42	.71	.75	[1].38	[1].61	.57	.64	1.20	.63	.42
21	----	.34	.35	.16	[1]1.50	[1].41	.67	.71	[1].36	.61	.56	.64	1.16	.61	.42
22	----	.33	.40	.15	[1]1.05	[1].41	.63	.70	[1].35	.61	.53	.66	1.10	.58	.41
23	0.44	.33	.36	.15	[1]1.50	[1].40	.57	.67	[1].34	.61	.51	.72	1.17	.71	.38
24	.43	.32	.38	.17	[1]1.45	[1].58	.57	.64	[1].33	.60	.50	.71	1.14	.73	.36
25	.64	.31	.35	.16	[1]1.00	[1].70	.58	.64	.37	.58	.58	.66	1.02	.64	.32
26	.76	.31	.28	.15	.88	[1].55	.54	.63	.35	.56	.67	.61	.98	.63	.29
27	.76	.33	.24	.15	1.09	[1].48	.52	.61	.34	.54	.61	.60	.97	.74	.29
28	.61	.30	.23	.14	.93	[1].50	.50	.60	.33	.53	.66	.58	.96	.71	.29
29	1.04	.28	.22	.14	[1].80	[1].49	.50	.58	[1].32	.52	.57	.58	1.35	.66	.29
30	.81	.28	.20	.14	[1].75	[1].48	.50	.56	[1].32	.60	----	.60	1.37	.63	.29
31	----	.36	----	.14	[1].80	----	1.09	----	[1].32	.58	----	.61	----	.82	----
Total	5.49	13.04	9.30	5.68	24.62	14.97	19.84	26.66	13.68	14.33	17.71	22.39	39.01	23.76	15.65
Average	----	0.42	0.31	0.18	0.79	0.50	0.64	0.89	0.44	0.46	0.50	0.72	1.30	0.77	0.52

[1] Estimated.

Table 3.1 Measured daily mean discharge at Marlboro Brook (Adapted from Perlmutter, 1962).

Miscellaneous discharge measurements, in cubic feet per second, of unnamed tributary, about 2,000 feet north of Marlboro Brook gaging station, 1955

Date	Discharge	Date	Discharge
April 29	0.20	August 15	0.07
May 9	.22	October 14	.12
June 17	.12	December 23	.21
July 19	.08		

Table 3.2 Measured daily mean discharge at Unnamed Brook (Adapted from Perlmutter, 1962).

3.7 SENSITIVITY ANALYSES

The process of calibration involves adjusting a number of key aquifer parameters in order to obtain a desired solution field, the interpreted water table surface. Although the calibrated parameters are within the range of acceptable and reported values, sensitivity analyses identifies critical aquifer parameters, thereby providing means for gauging the reliability of the model. Furthermore, sensitivity analyses also aids in planning and developing meaningful field studies for determining critical aquifer parameters. The response of the calibrated model to variations in the input parameters is discussed below.

3.7.1 Leakance

Sensitivity of the model to leakance between the glacial outwash and till units was first investigated by doubling and halving the leakance value between the two units. In either case, the impact on the calibrated water table was negligible. Similarly, the model was insensitive to the doubling and halving of leakance between the till and bedrock units.

3.7.2 Conductivity of the Lower two Modeled Units

The horizontal hydraulic conductivity of the two lowermost modeled units, which represents the till and bedrock formations, was doubled and halved both simultaneously and individually. For all cases, the change in the calibrated water table was insignificant. Therefore, as discussed earlier, these two units may be neglected for modeling purposes if the objective of the calibrated model is to reproduce the water table surface and simulate flow in the outwash.

3.7.3 Conductivity of the Topmost Modeled Unit

The topmost modeled unit represents the glacial outwash in most of the modeled domain except where the till and bedrock formations outcrop. The horizontal hydraulic conductivity in this layer was first reduced by 50 percent from the calibrated values. This resulted in a general increase in the water levels at the site. The resulting water table is presented in Figure 3.14. In the outcrops, the water levels increased by as much as 20 feet. This is to be expected since conductivity controls mounding in the outcrops. In the outwash, decreasing conductivity resulted

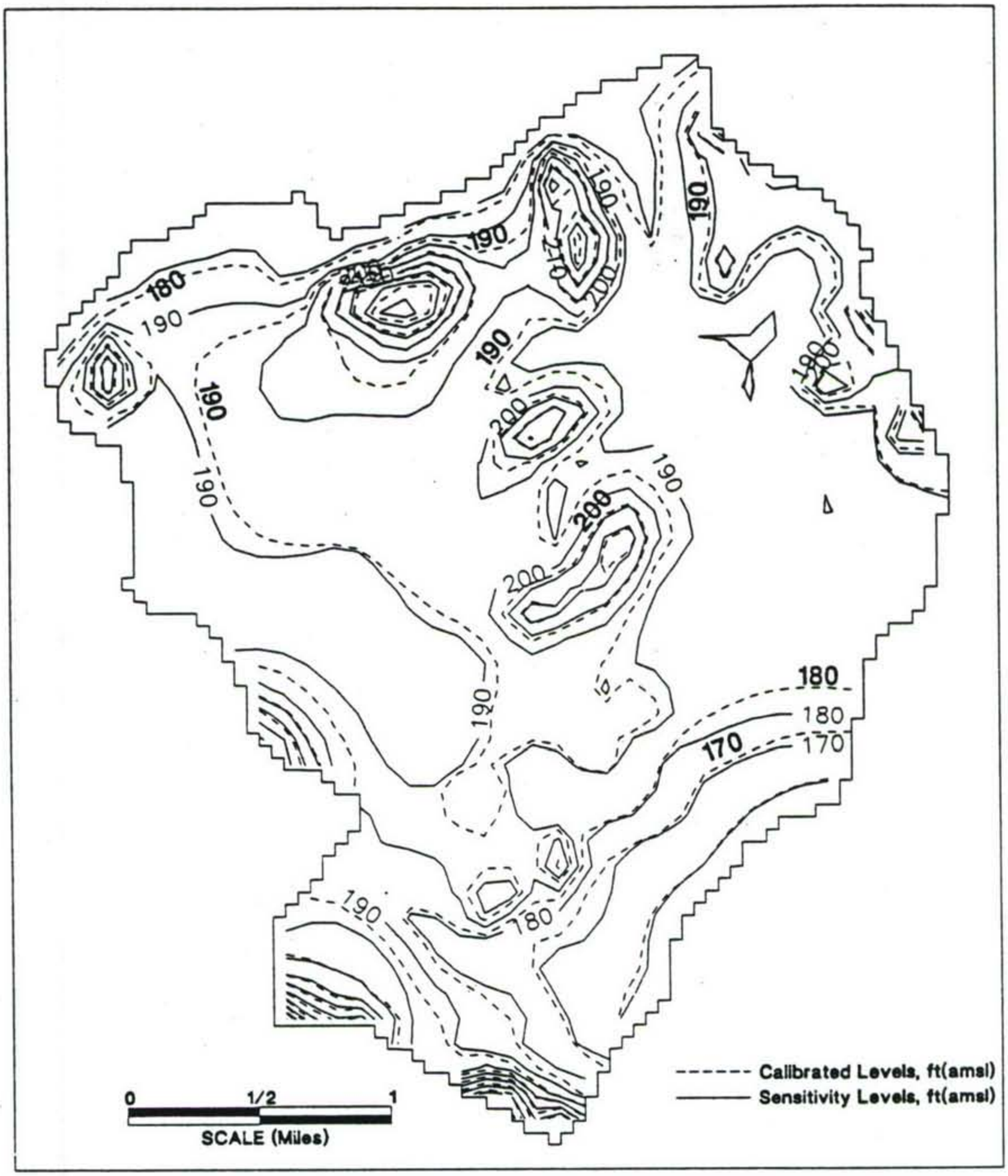

Figure 3.14 Water table for case with horizontal hydraulic conductivities in topmost modeled layer reduced 50 percent from calibrated values.

outcrops declined by about 15 feet, and the drop in the outwash varied from zero under the surface water bodies to less than 10 feet near the outcrops (Figure 3.15).

3.7.4 Recharge

The model was also very sensitive to the prescribed rate of infiltration. The calibrated rate of recharge was approximately 20 inches per year in the outwash and 10 to 15 inches per year in the outcrop. The overall recharge was first reduced by 50% from the calibrated values and as expected the water levels declined. However, since the head in the aquifer near the surface water bodies is controlled largely by the stage in the ponds/river, the change in water levels varies, remaining unchanged near the surface water features and declining up to 20 feet in the highland outcrops (Figure 3.16). Increasing recharge by 50%, as expected, had the opposite effect with water levels rising highest in the outcrops and staying approximately the same near ponds/rivers (Figure 3.17).

3.7.5 Varying Conductivity and Recharge Simultaneously

Since the watershed model of this study has no cross boundary flux or direct withdrawal from the subsurface, the steady-state groundwater flow in the domain may be expressed by:

$$\frac{\partial^2 h}{\partial n^2} + \frac{\partial^2 h}{\partial y^2} = \frac{R}{K}$$

This suggests that the hydraulic gradients and therefore the water levels are a function of the ratio of recharge (R) and horizontal conductivity (K).

A sensitivity run was conducted by doubling the calibrated recharge and conductivities in the outwash. As expected, the resulting water table (Figure 3.18) is nearly identical to the calibrated water table since the ratio $\left[\frac{R}{K}\right]$ remains unchanged from the calibrated base case.

Similarly, halving the recharge and conductivities in outwash resulted in a water table (Figure 3.19) almost identical to the calibrated case.

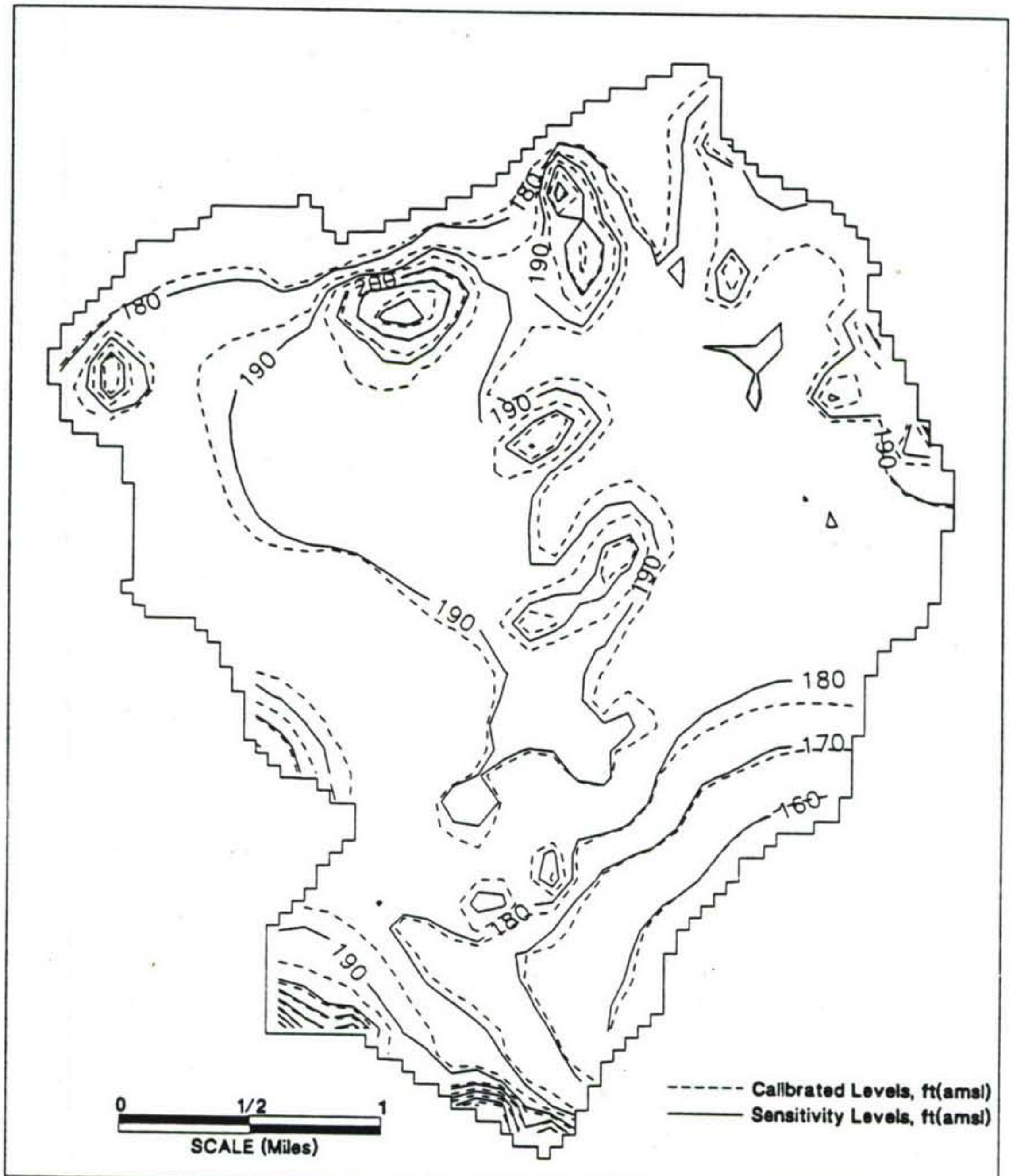

Figure 3.15 Water table for case with horizontal hydraulic conductivity in topmost modeled layer doubled from calibrated values.

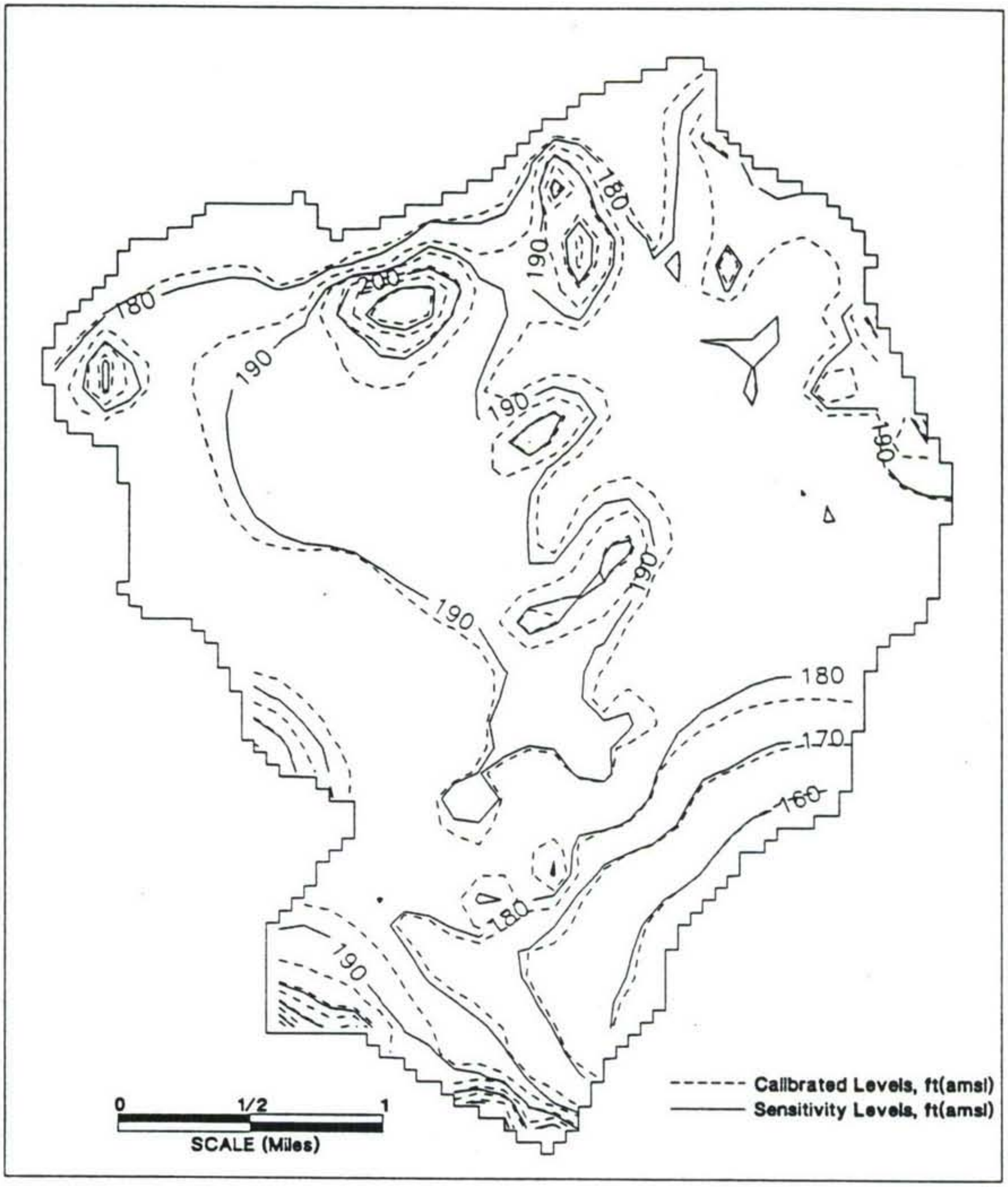

Figure 3.16 Water table for case with areal recharge reduced 50 percent from calibrated values.

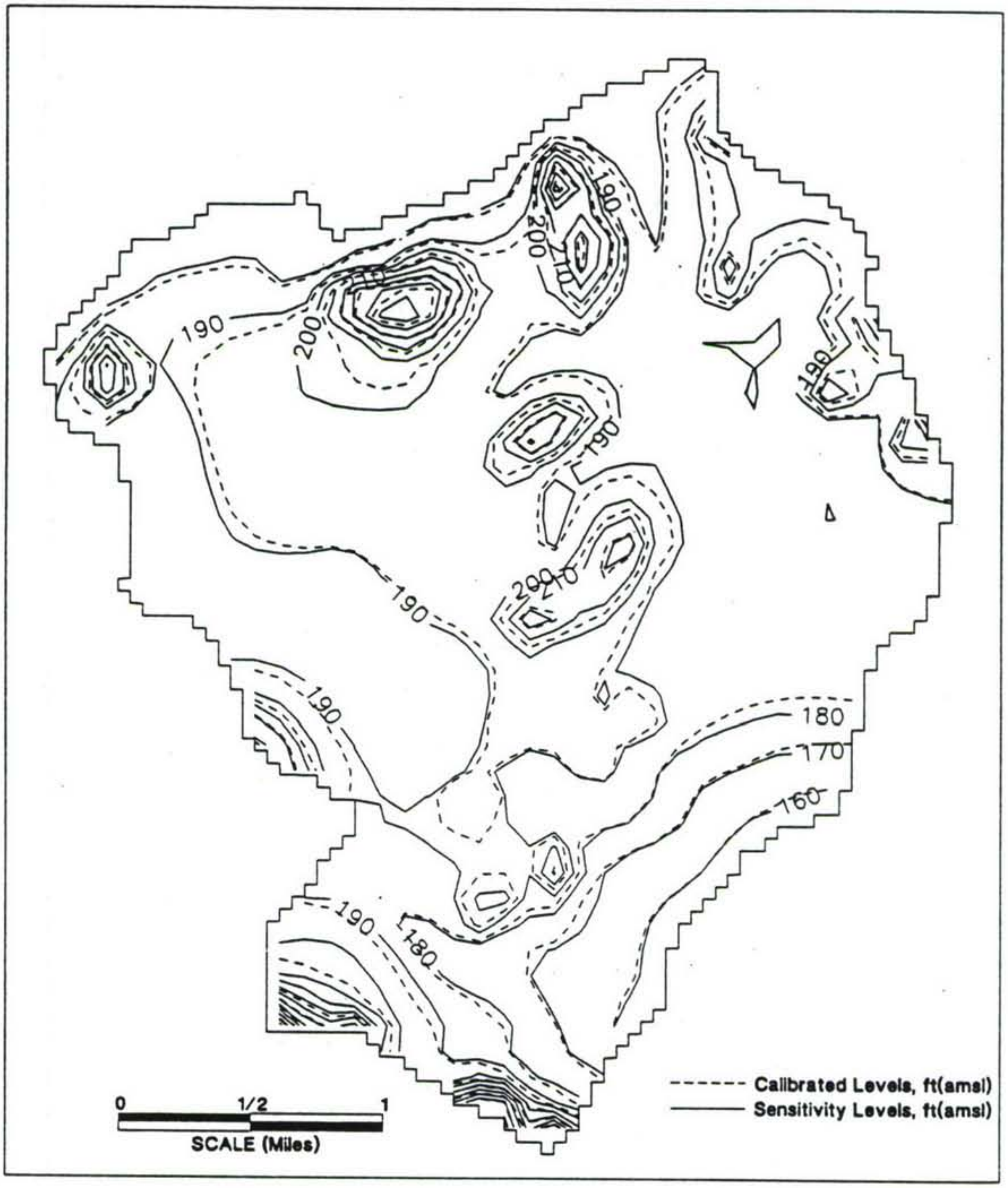

Figure 3.17 Water table for case with areal recharge increased 50 percent from calibrated values.

A sensitivity run was conducted by doubling the calibrated recharge and conductivities in the outwash. As expected, the resulting water table (Figure 3.18) is nearly identical to the calibrated water table since the ratio $\left(\frac{R}{K}\right)$ remains unchanged from the calibrated base case. Similarly, halving the recharge and conductivities in outwash resulted in a water table (Figure 3.19) almost identical to the calibrated case.

This implies that the calibrated water table may be reproduced if global variations to either the recharge or conductivities can be accompanied by a corresponding change to the other parameter. For example, if it is suggested that the actual rate of overall recharge is 25 inches rather than the calibrated value of 20 inches, then the calibrated water table may be replicated by increasing the conductivities by 25 percent. The rate of subsurface flow, however, depends only on the magnitude of recharge to the system.

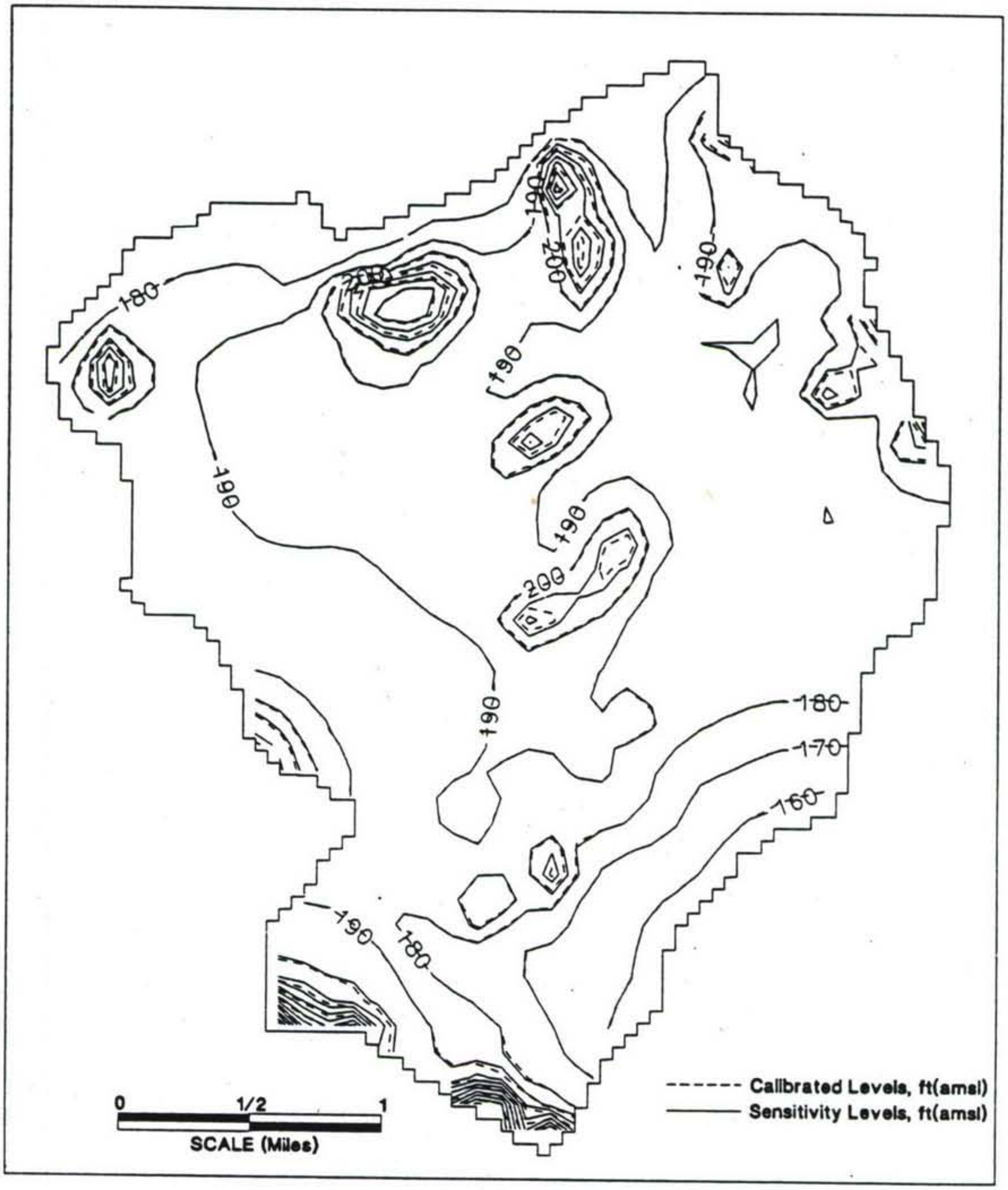

Figure 3.18 Water table for case with both areal recharge and horizontal conductivities in topmost layer doubled from calibrated values.

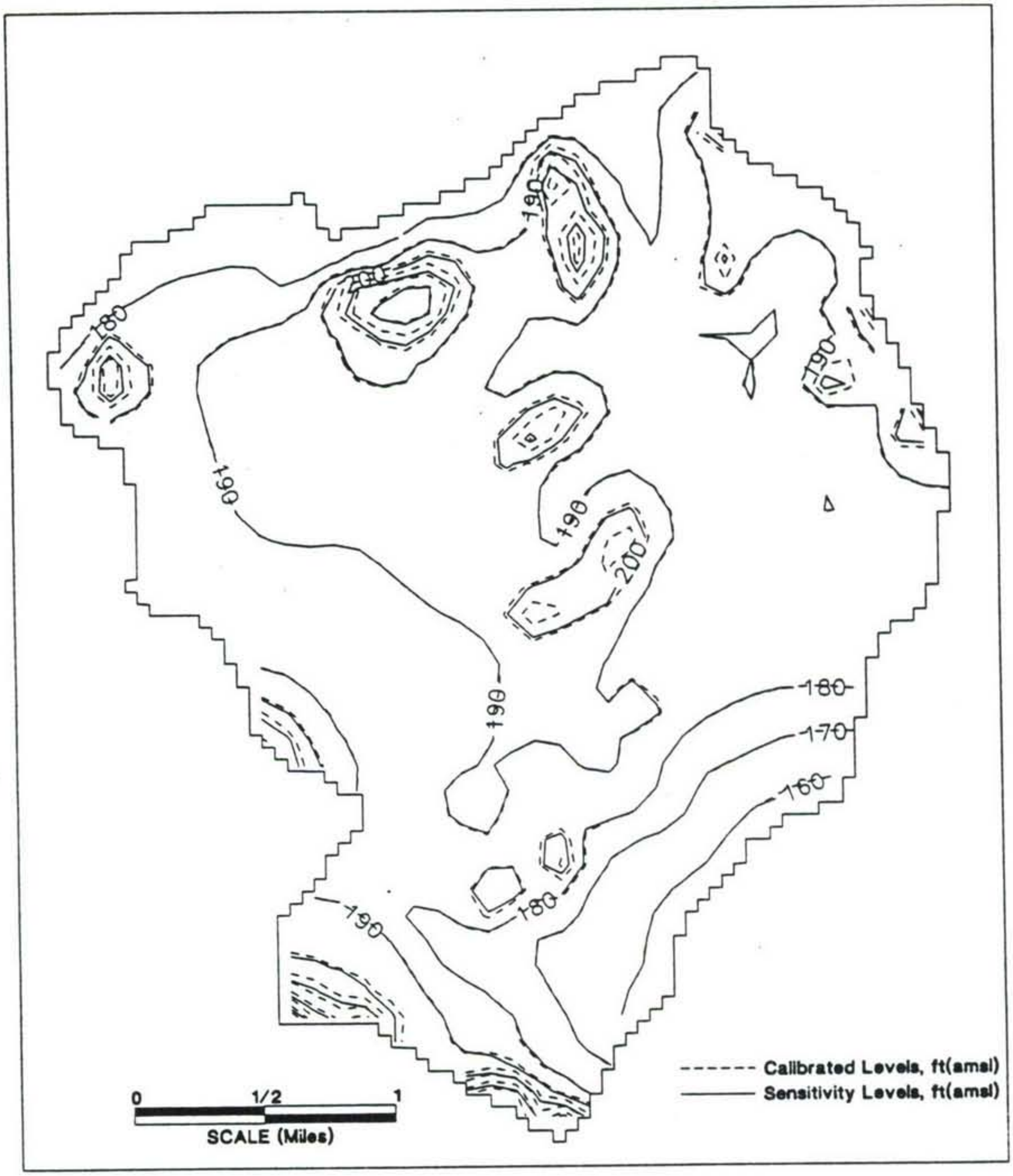

Figure 3.19 Water table for case with both areal recharge and horizontal conductivities in topmost modeled layer halved from calibrated values.

4.0 CONCLUSIONS

A groundwater model is developed which simulates subsurface flow through three geologic units at the Sudbury Training Annex and vicinity. The model accounts for hydraulic interaction between groundwater and surface water features at the site, and was calibrated to the long-term annual average water table.

The conceptual subsurface hydrodynamics at the site are confirmed by the model. Water enters the subsurface in the form of precipitation, recharging all three geologic units prior to discharging into the ponds, streams, and marshes at the site. The model delineates in detail the boundaries of all major and minor watersheds in the region. This will assist in future predictive and remedial investigative efforts. The model satisfactorily accounts for the contribution of groundwater to the estimated municipal withdrawal of surface water from White Pond by the Town of Maynard.

Aquifer parameters and boundary conditions were obtained or estimated after carefully reviewing all data sources pertinent to the site. The model was found to be significantly sensitive only to the ratio of areal recharge and horizontal hydraulic conductivities in the glacial outwash. Since there is good agreement between the interpreted and the calibrated water tables, and since the calibrated recharge to the model is well within the documented range, the model is considered well calibrated and capable of accurately simulating the direction and rate of flow in the subsurface. Therefore, the model should be useful for simulating the cumulative effects of multiple remedial actions and for providing boundary conditions for smaller scale models.

REFERENCES

Perlmutter, N.M., 1962. Groundwater Geology and Hydrogeology of the Maynard Area Massachusetts. US Geological Survey Water Supply Paper 1539-E.

Ecology and Environment, Inc., 1994. Fort Devens Sudbury Training Annex, Phase II Site Investigation Report, Vol. I, II and III. Prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland.

DuFrense-Henry, Inc., 1982. Report on Water Supply Investigation Tuttle Hill Area, Maynard, Massachusetts.

McDonald, M.G. and A.W. Harbaugh, 1988. A Modular Three-Dimensional Finite-Difference Groundwater Flow Model. Techniques of Water-Resources Investigations of the US Geological Survey, Book 6 Chapter A1.

Hansen, W.R., 1953, Late Tertiary and Pleistocene drainage changes in the Hudson and Maynard quadrangles, Massachusetts: Jour. Geology, v. 61, no. 4.

APPENDIX I

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

APPENDIX I

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Draft ARARs developed for the Fort Devens Sudbury Training Annex by the Oak Ridge National Laboratory were used to screen data collected during the Phase II SI conducted in 1993 by E & E at the Annex. Section 7 in Volume I of this SI report provides a discussion of how screening was performed, and presents other screening values used for the evaluation in cases where draft ARARs were not applicable. The two documents in this Appendix are:

1. Assessment of Location-Specific Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Devens Sudbury Training Annex, Massachusetts, February 21, 1994.

2. Assessment of Chemical-Specific Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Devens Sudbury Training Annex, Massachusetts, February 23, 1994.

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ASSESSMENT OF LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FORT DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 21, 1994

CHEMICAL HAZARD EVALUATION GROUP
BIOMEDICAL AND ENVIRONMENTAL
INFORMATION ANALYSIS SECTION
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ASSESSMENT OF LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FT. DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 21, 1994

Chemical Hazard Evaluation Group
Biomedical and Environmental Information Analysis Section
Health Sciences Research Division
Oak Ridge National Laboratory (1992)

ARAR TASK GROUP

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ASSESSMENT OF LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FT. DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

1. INTRODUCTION

The assessment of applicable or relevant and appropriate requirements (ARARs) is an integral part of the remediation process mandated under the Comprehensive Environmental Response, Compensation and Liability Act and the Superfund Amendments and Reauthorization Act [42 U.S.C. §§ 9601-9675 (1991)]. As the preamble of CERCLA states, the purpose of the law is "to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites." In addressing hazardous substances and sites, CERCLA provides that on-site remedial actions must meet the standards and criteria that are otherwise legally applicable to the substance, pollutant, or contaminant **or** that are relevant and appropriate under the circumstances [42 U.S.C. § 9621(d)(2)(A) (1991)].

To this end, potential ARARs are identified as early as the Remedial Investigation/ Feasibility Study phase and refined throughout the process as a result of site characterization, the development, screening, and selection of remedial alternatives, and the remedial design and action. Guidance for assessing and selecting ARARs is provided in the U.S. Environmental Protection Agency's (U.S. EPA) manual "CERCLA Compliance With Other Laws" (USEPA 1988; USEPA 1989).

CERCLA remedial actions may trigger several different types of requirements or ARARs. These are organized, for convenience sake, into three categories; chemical-specific, action-specific, and location-specific. However, these categories are not always mutually exclusive and there may be some conceptual overlapping. Chemical-specific ARARs are health- or risk-based numerical values for different chemical substances (USEPA 1988). Action-specific ARARs are usually technology- or activity-based requirements or limitations (USEPA 1988). This report will specifically address the last category, the location-specific ARARS. These are restrictions or requirements for substances or activities based primarily on their specific physical location (USEPA 1988).

In order to be classified as an ARAR, a requirement must be applicable **or** relevant and appropriate. As defined in the National Contingency Plan (NCP), **applicable** requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" [40 C.F.R. § 300.5 (1991)]. **Relevant and appropriate** requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" [40 C.F.R. § 300.5 (1991)].

In either case, an applicable or a relevant and appropriate requirement for on-site remedial action must be substantive. Compliance with administrative requirements is not mandated for on-site actions (USEPA 1988). Administrative requirements are those procedures "that facilitate the implementation of the substantive requirements of a statute or regulation" (USEPA 1988). For example, CERCLA specifically exempts on-site actions from federal, state and local permitting requirements [42 U.S.C. § 9621(e)(1) (1991)]. Furthermore, only those state requirements that are more stringent than federal requirements are ARAR [40 C.F.R. § 300.5 (1991)]. "More stringent" would also necessarily include those state laws or programs that have no federal counterpart as "they add to the Federal law requirements that are specific to the environmental conditions in the State" (USEPA 1989). State requirements must be adopted by formal means (i.e. promulgated) and generally applicable (i.e. not just to Superfund sites, but to all circumstances addressed in the requirement) [42 U.S.C. § 9621(d)(2)(C)(iii)(I) (1991)].

Finally, there is a category of requirements called "To Be Considered" (TBC) guidance that may appear in this document. These are guidelines or advisories that are issued by the federal or state government, but which are neither legally binding nor promulgated (USEPA 1988). However, these guidelines may be used when they are necessary to ensure protection of public health and the environment and when they have not been superseded (USEPA 1988). If no ARARs address a particular circumstance at a CERCLA site, or if the ARARs available do not ensure protectiveness, then TBCs can be used to establish remedial guidelines or targets.

2. LOCATION-SPECIFIC ARARs

Table 1 lists the major federal and Commonwealth location-specific ARARs that might be pertinent to remedial actions at Fort Devens Sudbury Training Annex (Sudbury Annex). TBC guidance is addressed, where appropriate, in the text only.

2.1. Faults

Sudbury Annex is located near the western boundary of the Seaboard Lowland Section of the New England-Maritime Physiographic Province (EEI 1993). This area is characterized by glacial deposits underlain by a complex of metamorphic and igneous rock in tightly-folded bedrock units (EEI 1993). There are numerous faults in the area of Sudbury Annex (Foster 1994). However, they generally date to the early-Paleozoic period and there are no faults with Holocene displacement under the facility or in its vicinity (Foster 1994). The area has experienced a number of major earthquakes since the early 1700's that, while not involving fault displacement, have involved liquification of sediments (Sinnott 1992). Interestingly, earthquakes in the eastern part of the country are not associated with faults, as are those in the western United States (Oldale 1993). Rather, they are deep seated in the crust and there is, in fact, a significant earthquake potential in the northeastern United States (Oldale 1993).

Under current RCRA regulations, Sudbury Annex is exempted from compliance with the RCRA seismic requirements of 40 C.F.R. § 264.18 (1992) since § 264.18(a) stipulates that all facilities located within political jurisdictions other than those listed in Appendix VI are assumed to be in compliance for location of new treatment, storage or disposal (TSD) facilities. Massachusetts is not listed in the Appendix. EPA had intended to propose additional restrictions for location of TSD facilities; however, the rule has been put on hold because the Office of Management and Budget disagreed with the basic premise of the rule. If additional restrictions are proposed, they will be evaluated for their relevance to remedial actions at Sudbury Annex.

TABLE 1. Tentative Location-Specific Applicable or Relevant and Appropriate Requirements for FDSTA

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
Floodplains			
· Within 100-year floodplain	· Treatment, storage or disposal facility · RCRA[a]-defined listed or characteristic hazardous waste [40 C.F.R. § 261 (1992)] -or- RCRA-permitted facility	· Facility must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by 100 year flood.	· 40 C.F.R. § 264.18(b) (1992)
· Within "lowland and relatively flat areas adjoining inland and coastal waters and other floodprone areas such as offshore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year." [Executive Order 11988 § 6(c) and 40 C.F.R. § 6, Appendix A § 4(d) (1992)]	· Federal agency action which involves: - acquiring, managing, and disposing of lands and facilities - providing federally undertaken, financed, or assisted construction and improvements - conducting federal activities and programs affecting land use	· Federal agencies shall take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of floodplains. · Federal agencies shall evaluate potential effects of actions in floodplains and ensure consideration of flood hazards and floodplain management. · If action is taken in floodplains, federal agencies shall consider alternatives to avoid adverse effects, incompatible development, and minimize potential harm.	· Executive Order 11988 · 40 C.F.R. § 6.302(b) (1992) · 40 C.F.R. § 6, Appendix
· Inland and coastal land subject to flooding	· Treatment, storage or disposal facility subject to regulations under Mass. Regs. Code[b] tit. 310, § 30.800 (1989)	· Active portions of new treatment or storage facilities are prohibited within the boundary of land subject to flooding from the statistical 100-year frequency storm. · Active portions of landfills, land treatment units, surface impoundments, or waste piles are prohibited within the boundary of land subject to flooding from the statistical 500-year frequency storm.	· Mass. Regs. Code tit. 310, § 30.701(6) (1989)
· Inland and coastal land subject to flooding from the statistical 500-year frequency storm	· Landfills, land treatment unit, surface impoundment, or waste pile subject to regulation under Mass. Regs. Code tit. 310, § 30.800 (1989)	· Active portion of landfills, land treatment units, surface impoundments, or waste piles are prohibited within the boundary of land subject to flooding from the 500-year frequency storm.	· Mass. Regs. Code tit. 310, § 30.701(6) (1989)

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
· Land subject to flooding as defined in Mass. Regs. Code tit. 310, § 10.57(2) (1989)	· Activities within the area subject to flooding which involve removal, filling, dredging, or alteration of the area, as defined in Mass. Regs. Code tit. 310, § 10.04 (1989). · Activities within 100 feet of land subject to flooding which would alter the area.	· Actions in "bordering land subject to flooding" shall provide compensatory storage for flood storage volume lost as a result of the project, shall not restrict flows so as to cause an increase in flood stage or velocity, and shall not impair its capacity to provide important wildlife habitat functions or alter vernal pool habitat. · Actions in "isolated land subject to flooding" shall not result in flood damage because of lateral displacement of water that would otherwise be confined within the area, adverse effects on water supply or ground water supply, adverse effects on the capacity of the area to prevent ground water pollution, or adverse effects on vernal pool habitat.	· Mass. Gen. L.[c] ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989)
Wetlands			
· Presence of wetlands as defined in Executive Order 11990, § 7(c) and 40 C.F.R. § 6, Appendix A, § 4(j) (1992)	· Federal agency action which involves: - acquiring, managing, and disposing of lands and facilities - providing federally undertaken, finances, or assisted construction and improvements - conducting federal activities and programs affecting land use	· Whenever possible, federal agency actions must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. Agencies should particularly avoid new construction in wetlands areas unless there are no practicable alternatives. · Federal agencies shall incorporate wetlands protection considerations into planning, regulating, and decision-making processes.	· Executive Order 11990 · 40 C.F.R. § 6.302(a) (1992) · 40 C.F.R. § 6, Appendix A (1992)
· Presence of wetlands as defined in 40 C.F.R. § 230.3(t) (1992) and 33 C.F.R. § 328.3(b)*	· Action involving discharge of dredge or fill material into wetlands	· Action must be taken to avoid degradation or destruction of wetlands to the extent possible. Discharges for which there are practicable alternatives with less adverse impacts or those which would cause or contribute to significant degradation are prohibited. · If adverse impacts are unavoidable, action must be taken to enhance, restore, or create alternative wetlands.	· Clean Water Act § 404 [33 U.S.C. § 1344 (1991)] · 40 C.F.R. § 230 (1992) · 33 C.F.R. §§ 320-330*

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
· Presence of wetlands as defined in Mass. Gen. L. ch. 130, § 105 (1990) or Mass. Gen. L. ch. 131, § 40 (1990), or regulations pursuant to those statutes	· Landfills, land treatment unit, surface impoundment, or waste pile subject to regulation under Mass. Regs. Code tit. 310, § 30.800 (1989) · Hazardous waste subject to regulation under Mass. Regs. Code tit. 310, § 30.000 (1989)	· Active portions of designated facilities cannot be constructed in, or expanded into, wetlands.	· Mass. Regs. Code tit. 310, § 30.705(6) (1989)
· Presence of any bank, freshwater wetland, coastal wetland, beach, dune, flat, marsh, meadow, or swamp bordering on the ocean or on any estuary, creek, river, stream, pond, or lake **or** any land under these waters **or** land subject to tidal action, coastal storm flow, or flooding	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Removal, filling, dredging, or alteration of protected area is prohibited except under the conditions and criteria delineated in Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989).	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989)
· Presence of any bank, freshwater wetland, coastal wetland, beach, dune, flat, marsh, meadow, or swamp bordering on the ocean or on any estuary, creek, river, stream, pond, or lake **or** any land under these waters **or** land subject to tidal action, coastal storm flow, or flooding	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Removal, filling, dredging, or alteration of protected area is prohibited except under the conditions and criteria delineated in Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989). - **Applicable**	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989)
Wilderness areas, wildlife resources, wildlife refuges, or scenic rivers			
· Within area affecting stream or river - **and**- presence of fish or wildlife resources	· Action which results in the control or structural modification of a natural stream or body of water	· The effects of water-related projects on fish and wildlife resources must be considered. · Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. · Off-site actions which alter a resource require consultation with the FWS[d], NMFS[e], and/or the appropriate state agency. · Consultation with the responsible agency is also strongly recommended for on-site actions.	· Fish and Wildlife Coordination Act (16 U.S.C. § 661*) · 40 C.F.R. § 6.302(g) (1992)
· Location encompassing aquatic ecosystem with dependent fish, wildlife, other aquatic life, or habitat	· Action involving the discharge of dredge or fill material into aquatic ecosystem	· Degradation or destruction of aquatic ecosystems must be avoided to the extent possible. Discharges which cause or contribute to significant degradation of the water of such ecosystem are prohibited.	· Clean Water Act § 404 [33 U.S.C. § 1344 (1991)] · 40 C.F.R. § 230(1992) · 33 C.F.R. §§ 320-330*

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
· Presence of areas such as wetlands, etc., as listed in Mass. Regs. Code tit. 310, § 10.02(1) 1989), which due to their plant community composition and structure, hydraulic regime, or other characteristics, provide important food, shelter, migratory or overwintering areas, or breeding areas for wildlife	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Actions which would have adverse effects on specific habitat characteristics and the important functions they serve are prohibited or regulated if they exceed certain threshold levels delineated in the regulations.	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10..00-10.60 (1989)
<u>Endangered, threatened or rare species</u>			
· Presence of endangered or threatened species, or critical habitat (see above citation) of same, within an aquatic ecosystem as defined in 40 C.F.R. § 230.3(c) (1992)	· Action involving discharge of dredge or fill material into aquatic ecosystem	· Dredge or fill material shall not be discharged into an aquatic ecosystem if it would jeopardize such species or would likely result in the destruction or adverse modification of a critical habitat of the species.	· Clean Water Act § 404 [33 U.S.C.§ 1344 (1991)] · 40 C.F.R. § 230.10(b) (1992)
· Presence of endangered or threatened species **-or-** critical habitat of such species as designated in 50 C.F.R. § 17 (1989), 50 C.F.R. § 226 (1989), or 50 C.F.R. § 227 (1989)	· Action which is likely to jeopardize species or destroy or adversely modify critical habitat	· Actions which jeopardize species/habitat must be avoided or appropriate mitigation measures taken. · Off-site actions which affect species/habitat require consultation with DOI, FWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. · Consultation with the responsible agency is also strongly recommended for on-site actions.	· Endangered Species Act of 1973 (16 U.S.C. §§ 1531-1543*) · 50 C.F.R. § 402 (1989) · 40 C.F.R. § 6.302(h) (1992) · Fish and Wildlife Coordination Act (16 U.S.C. § 661*)
· Presence of significant habitats of state-listed species as designated pursuant to Mass. Gen. L. ch. 131A (1991)	· Action likely to alter significant habitat	· Actions which alter significant habitat are prohibited if the alteration will likely reduce the viability of a significant habitat.	· Mass. Gen. L. ch. 131A (1991) · Mass. Regs. Code tit. 321, §§ 10.00-10.61 (1992)
· Presence of a protected resources area, as designated in Mass. Regs. Code tit. 310, § 10.02(1) (1989), which is part of the habitat of a state-listed species	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Short or long term adverse effects on the habitat of the local population of the listed species are prohibited.	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, 10.00-10.60 (1989)

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
Archaeological and historic resources			
· Presence of archaeological or historic resources	· Action involving dam construction or other alteration of terrain which might cause irreparable loss or destruction of significant scientific, prehistoric, historic, or archaeological data	· The Secretary of the Interior must be advised of the presence of such data. · A survey must be conducted of affected areas for resources and data. Steps must be taken to recover, protect, and preserve data therefrom or DOI formally requested to do so.	· Archaeological and Historic Preservation Act [16 U.S.C. §§ 469(a)-469(c)*] · 40 C.F.R. § 6.301 (1992) · 32 C.F.R. § 650.181*
· Presence of federally owned, administered, or controlled prehistoric or historic resources -or- the likelihood of undiscovered resources		· Cultural resources included on, or eligible for inclusion on, the National Register of Historic Places (36 C.F.R. § 60*) or National Historic Landmark Program (36 C.F.R. § 65*) must be identified. · A determination must be made as to whether proposed action(s) will affect such resources and, if so, alternatives to the action(s) must be examined and considered. · When alteration or destruction of the resource is unavoidable, steps must be taken to minimize or mitigate the impacts and to preserve records and data of the resource. · When all or part of a remedial action is off-site, the consultation requirements of 16 U.S.C. § 470(f)* must be completed. · Consultation is also strongly recommended for on-site actions.	· National Historic Preservation Act [16 U.S.C. §§ 470(a)-470(w)* · Executive Order 11593 · 40 C.F.R. § 6.301 (1992) · 36 C.F.R. § 800* · 32 C.F.R. § 650.181*

[a]RCRA = Resource Conservation and Recovery Act; definitions appear at 40 CFR 260.10
[b]Mass. Regs. Code = Code of Massachusetts Regulations
[c]Mass. Gen. L. = Massachusetts General Laws
[d]FWS = U. S. Fish and Wildlife Service
[e]NMFS = National Marine Fisheries Service
[f]DOI = Department of Interior

2.2. Caves, salt-dome formations, salt-bed formations, and underground mines

Sudbury Annex is located in north central Massachusetts in Middlesex County and includes areas within the towns of Maynard, Hudson, Marlboro, Stow, and Sudbury. The installation is divided into a larger, northern section (upper section) and a smaller, southern section (lower section) by Hudson Road. The terrain is broad flat plains with scattered hills along the northern edge of the upper section, concentrating primarily in the north-central area (EEI 1993). The hilly portions consist of glacial till, with glacial outwash comprising the flat areas (EEI 1993). There are no salt formations or caves on Sudbury Annex (Foster 1994). In addition, there are no underground mines at the installation. (Foster 1994). Therefore, no ARARs developed under this location-specific category.

2.3. Floodplains and wetlands

There are abundant surface water resources on and around Sudbury Annex. The Assabet River flows adjacent to the northwestern side of the upper section (EEI 1993). Puffer Pond is located in the east central part of the upper section with Willis Pond straddling on both sides of the eastern boundary of that section. Cutting Pond and Vose Pond are located just beyond the eastern boundary, to the north of Willis Pond (EEI 1993). Crystal Lake is situated southeast of the upper section of Sudbury Annex and northeast of the lower section. White Pond and Lake Boon are just beyond installation boundaries, south/southwest of the upper section and west/northwest of the lower section. White Pond is a source of water supply for the Town of Maynard (EEI 1993). Maps of Sudbury Annex also show several small, unnamed waterbodies in the central and north-central portion of the upper section and in the eastern portion of the lower section (EEI 1993).

In addition to the open waterbodies listed above, the Assabet River flows along the northwestern border of the upper section of Sudbury Annex. There are also a number of perennial and intermittent streams on the installation (EEI 1993). Taylor Brook flows northward across the upper portion of Sudbury Annex and, along with its tributaries, drains that section of the installation into the Assabet River (EEI 1993). The western and southwestern portions of the upper section drain into White Pond and Lake Boon (EEI 1993). Marlboro Brook flows east across the lower section of the installation into Hop Brook just east of Sudbury Annex.

As might be expected, given the abundant water resources on and around Sudbury Annex, there are floodplains associated with the river (EEI 1993). It is also likely that there are floodplains associated with the streams and ponds on the installation; however, a survey or summary is not available. Additionally, the various state and federal laws addressing floodplains entail varying definitions of the resources covered under their provisions. Therefore, particular attention should be paid to the definitions and jurisdictional requirements of each statute and/or regulation.

Remedial actions that impact floodplains, depending on the particulars of the action and the location, could be subject to requirements under 40 C.F.R. § 264.18(b) (1992), Executive Order 11988, 40 C.F.R. § 6.302(b) (1992), and 40 C.F.R. § 6, Appendix A (1992). TSD facilities, landfills, land treatment units, surface impoundments, and waste piles which impact inland or coastal land subject to flooding are regulated under Mass. Regs. Code tit. 310, § 30.701(6) (1989) which would also be ARAR if the remedial action taken fall within its perview. The removal, dredge, fill, or alteration of land subject to flooding is addressed at Massachusetts General Laws (Mass. Gen. L.) ch. 131, § 40 (1990) and Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989). These

regulations would be applicable to actions that impact "bordering land subject to flooding" and "isolated land subject to flooding." The definitions, critical characteristics, and boundaries of protected areas are delineated in Mass. Regs. Code tit. 310, § 10.57(2) (1989). Assistance in addressing these Commonwealth provisions may be found in the Wetlands Protection Program Policy 85-2, "Isolated Land Subject to Flooding." Wildlife resources and rare species are also addressed under Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989). However, those provisions will be examined in more detail under sections 2.4 and 2.5 of this document.

Given that 81% of Sudbury Annex is characterized as lowlands, it is not surprising that there are numerous wetlands scattered over much of the installation (EEI 1993; Aneptek 1991). A complete description of all of these resources is beyond the scope of this text, but resource material is readily available and includes the National Wetlands Inventory Maps, the *Master Environmental Plan - Fort Devens Sudbury Training Annex, Sudbury, Massachusetts* (EEI 1993), and the *U.S. Army Natick Research, Development and Engineering Center Endagered Species Survey - Phase I: An Environmental Inventory of Wildlife Species and Their Habitats* [(See particularly Section 5 - U.S. Army Fort Devens Sudbury Annex - Taylor Drop Zone and Section 6 - Hudson (Capeheart Housing Area (lower section Sudbury Annex)] (Aneptek 1991). Briefly, the most common types of wetlands include bottomland hardwood forests along the river floodplains and the edges of water bodies, shrub swamps, which tend to be fairly stable, and freshwater emergent marshes (EEI 1993; Aneptek 1991). The latter are particularly important for waterfowl (EEI 1993).

Any remedial activities that impact wetlands may develop applicable requirements under Executive Order 11990, 40 C.F.R. § 6.302(a) (1992), 40 C.F.R. § 6, Appendix A (1992), the Clean Water Act § 404 [33 U.S.C. § 1344 (1991)], 40 C.F.R. § 230 (1992), and 33 C.F.R. §§ 320-330 (1992). Massachusetts regulations located at Mass. Regs. Code tit. 310, § 30.705(6) (1989) prohibit location of the active portion of a landfill, land treatment unit, surface impoundment, or waste pile within a wetland and Mass. Regs. Code tit. 310, § 16.40(3) (1990) prohibit the location of a solid waste landfill within a resource area protected by the Wetlands Protection Act. For the purposes of these regulations wetlands are defined according to Mass. Gen. L. ch. 130, § 105 (1990), Mass. Gen. L. ch. 131, § 40 (1990), and the regulations promulgated pursuant to those statutes. Any activities involving dredging, filling, removal, or alteration of wetlands, wet meadows, etc. would also be subject to requirements under the Wetland Protection Act, Mass. Gen. L. ch. 131, § 40 (1990), and the Wetlands Protection Regulations at Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989).

While these latter Commonwealth requirements regulate the same activities as the federal requirements in and pursuant to the Clean Water Act, they are "stricter" in that they address protection to a wider variety of resources, including wetlands, banks, dunes, etc. [see Mass. Regs. Code tit. 310, § 10.02(1) (1989)]. In addition, the regulations restrict activities within 100 feet of the wetland or other resource, in the "Buffer Zone," and provide protection for wildlife resources and rare species. These regulations are very comprehensive and a complete analysis of their provisions is beyond the scope of this document. They should be carefully reviewed and to the extent that the coverage of the regulations are broader than the federal counterpart, they would be applicable for actions subject to the regulations that impact protected resources. Assistance in addressing these regulations may be found in Wetlands Protection Program Policy 85-1, "Interpretation of Identified Vegetation," and Wetlands Protection Program Interim Guidance 90-TG1, "Aquatic Plant Control."

2.4. Wilderness areas, wildlife refuges, wildlife resources, scenic rivers

There are no scenic rivers, wildlife refuges or wilderness areas on Sudbury Annex, or within impact range of the installation. However, Sudbury State Forest is located just outside the southern edge of the upper section of the installation, between that portion and the lower section (EEI 1993; Aneptek 1991). If any remedial activities appear likely to impact this resource, the appropriate state official and/or management personnel should be contacted for guidance as to any requirements.

Given the natural resources and habitats on Sudbury Annex, the presence of wildlife resources is predictable. Sources for more detailed descriptions include the *Master Environmental Plan - Fort Devens Sudbury Training Annex, Massachusetts* (EEI 1993) and the *U.S. Army Natick Research, Development and Engineering Center Endagered Species Survey - Phase I: An Environmental Inventory of Wildlife Species and Their Habitats* [(See particularly Section 5 - U.S. Army Fort Devens Sudbury Annex - Taylor Drop Zone and Section 6 - Hudson (Capeheart Housing Area (lower section Sudbury Annex)] (Aneptek 1991). Particular note should be taken of the presence of, and the potential for, vernal pool habitats on Sudbury Annex (EEI 1993; Aneptek 1991).

Any remedial activity that results in the control of a natural stream or water body with fish or wildlife resources may be subject to applicable requirements under the Fish and Wildlife Coordination Act (16 U.S.C. § 661 (1992)) and 40 C.F.R. § 6.302(g) (1992). Any action involving the discharge of dredge or fill material into an aquatic ecosystem with dependant fish, wildlife, other aquatic life, or habitat would dictate consideration of the Clean Water Act § 404 [33 U.S.C. § 1344 (1991), 40 C.F.R. § 230 (1992), and 33 C.F.R. §§ 320-330 (1992). Remedial activities involving removal, alteration, dredging or filling, of wetlands, lands subject to flooding, and various other areas would also implicate applicable requirements under Mass. Gen. L. ch. 131, § 40 (1990) and Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989), which provide protection for certain wildlife habitats that provide important food, shelter, migratory or overwintering areas, or breeding areas for wildlife. Vernal pool habitats receive special consideration under these regulations and there are certain thresholds established for impacts in other areas. The Massachusetts regulations are very comprehensive and should be reviewed in detail if protected resources are identified in any location where remedial activities will occur. Assistance in this process may be found in Wetlands Protection Program Policy 88-1, "Inland Wildlife Habitats," Wetlands Protection Program Policy 88-5, "Wetlands Wildlife Advisory," and Wetlands Protection Program Interim Guidance 90-TG1, "Aquatic Plant Control."

2.5. Rare, threatened, or endangered species

Recent studies and observations at Sudbury Annex have identified a number of rare, threatened, or endangered species at the installation (EEI 1993; Aneptek 1991). A list of rare, threatened, and endangered species is provided in Table 2-5 of the *Master Environmental Plan - Fort Devens Sudbury Training Annex* (EEI 1993). There is some controversy regarding the grass-leaved Ladies' Tress (*Spiranthes Vernalis*), a state species of special concern. This species was documented by Aneptek during an endangered species survey that included portions of Sudbury Annex, specifically the Taylor Drop Zone and the Hudson (Capeheart) Housing Area (lower portion) (Aneptek 1991). Apparently, the presence of the plant was disputed by a later survey (EEI 1993).

If any rare, threatened, or endangered species are impacted by remedial activities at Sudbury Annex, applicable requirements may develop under the Endangered Species Act of 1973 (16 U.S.C. §§ 1531-1543 (1992), 50 C.F.R. § 17 (1989), 50 C.F.R. § 402 (1989), 40 C.F.R. § 6.302(h) (1992), and the Fish and Wildlife Coordination Act (16 U.S.C. § 661 (1992)). Moreover, any activity involving the discharge of dredge or fill material into an aquatic ecosystem would invoke the provisions of the Clean Water Act § 404 [33 U.S.C. § 1344 (1991) and 40 C.F.R. § 230.10(b) (1992) as applicable requirements. Mass. Regs. Code tit. 310, § 16.40 (4)(c) (1990) prohibit the location of a solid waste landfill in an area that would have an adverse impact on an endangered, threatened, or special concern species or on an ecologically significant natural community listed by the Natural Heritage and Endangered Species Program. The Massachusetts Wetlands Protection Act (Mass. Gen. L. ch. 131, § 40 (1990) and its regulations (Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989) provide requirements that would apply if a remedial activity alters a protected resources area [see Mass. Regs. Code tit. 310, § 10.02 (1989)] that is part of the estimated habitat of a rare species. "Estimated Habitat Maps" for rare state-listed species are available from the Massachusetts Natural Heritage and Endangered Species Program. Assistance in addressing these Commonwealth regulations may be found in Wetlands Protection Program Policy 90-2, "Rare Species Habitat." Furthermore, if any habitat of a state-listed species on FTD is designated by Massachusetts as "significant habitat," the substantive requirements of the Massachusetts Endangered Species Act [Mass. Gen. L. ch. 131A (1991)], and its attendant regulations located at Mass. Regs. Code tit. 321, §§ 10.00-10.61 (1992), would be applicable.

2.6. Archaeological resources and historic sites

Prior to the development of Sudbury Annex and the surrounding towns, the principle land use in the area was agriculture (EEI 1993; Aneptek 1991). In 1984 a survey of cultural resources over approximately 20% of the installation was completed pursuant to the installation's responsibilities for these resources under federal legislation (EEI 1993). The survey identified twenty-eight (28) historic sites, two of which, the remains of Rice or Vose Tavern and the Puffer family homestead, were deemed potentially significant (EEI 1993). The survey also identified twenty-five prehistoric sites (EEI 1993). Three of these are apparently considered potentially significant, but further information regarding their descriptions and locations, etc. is not available at this time (EEI 1993). In addition, the Taylor Testing Area (Taylor Drop Zone) is the only facility in the United States that performs certain specific testing procedures involving materials dropped from remote control, drone airplanes (Aneptek 1991).

If any archaeological or historic resources are impacted by remedial activities, applicable requirements would develop under the Archaeological Resources Recovery Act of 1979 [16 U.S.C. §§ 470(aa)-470(ll) (1992)], 43 C.F.R. § 7 (1992), 32 C.F.R. § 229 (1992), the Archaeological and Historic Preservation Act [16 U.S.C. §§ 469(a)-469(c) (1992)], 40 C.F.R. § 6.301 (1992), and 32 C.F.R. § 650.181 (1992). In addition, any property that is eligible for the National Register of Historic Places or the National Historic Landmark Program, would be subject to applicable requirements under the National Historic Preservation Act [16 U.S.C. §§ 470(a)-470(w) (1992)], Executive Order 11593, 40 C.F.R. § 6.301 (1992), 36 C.F.R. § 800 (1992), and 32 C.F.R. § 650.181 (1992).

Massachusetts addresses the protection of historical and archaeological resources in the Antiquities Act located at Mass. Gen. L. ch. 9, § 26 (1992). The statute specifically authorizes the administration of the National Historic Preservation Act [16 U.S.C. §§ 470(a)-470(w) (1992)] within the Commonwealth at Mass. Gen. L. ch. 9, § 27B (1992). The state register of historic places includes, among others, all properties listed on or eligible for the National Register of

Historic Places. Under regulations located at Mass. Regs. Code tit. 950, §§ 71.01-71.12 (1989) the Massachusetts Historical Commission (MHC) reviews any projects affecting the resources on the state list to determine if there will be adverse impacts on the resources and, if so, how to eliminate or mitigate those impacts. However, the MHC does not have veto power over projects as such and the regulations are not strictly "applicable" to CERCLA cleanup sites. However, relevant and appropriate requirements for remedial actions that impact state-listed resources can be found at Mass. Regs. Code tit. 950, § 71.05 (1989), which is promulgated pursuant to Mass. Gen. L. ch. 9, §§ 26-27C (1992).

Although not required, the process of consultation with the MHC to eliminate or mitigate adverse impacts may be recommended if any remedial alternatives at Sudbury Annex impact historical or archaeological resources. This is particularly true in light of the federal mandate to protect and preserve historical and archaeological resources and data and the fact that the federal review can be accomplished in conjunction with review by the MHC. Indeed, Mass. Regs. Code tit. 950, § 71.04(2) (1989) contemplates such coordination by providing that the review required under section 106 of the National Historic Preservation Act be undertaken, pursuant to Mass. Gen. L. ch. 9, § 27B (1992), by submission of the notification to the MHC.

2.7. Miscellaneous requirements

The Commonwealth regulations addressing TSD facility and solid waste landfill siting requirements have been discussed in Sections 2.3, 2.4, and 2.5 concerning impacts to floodplains, wetlands, wildlife resources, and endangered, threatened, or rare species. In addition, it is important to note that these regulations, located at Mass. Regs. Code tit. 310, §§ 30.700-30.707 (1989) and Mass. Regs. Code tit. 310, § 16.40(3) - (4) (1990), also address location requirements that involve resources not previously included in this document. These regulations require that the location of any new facility be evaluated with regard to transportation risks associated with the waste(s), adequacy of the buffer zone between active portions of the facility and areas of public access, population density in the vicinity of the site, proximity to "sensitive receptors" (eg. schools, hospitals, day care centers, residential dwellings, etc.), and proposed methods of evacuation of any populations that might be threatened in the event of any accident. In addition, buffer zones are required between the active portions of various facilities and their facility property lines and active farmland. These regulations may be relevant and appropriate requirements should the items or resources, etc. subject to the regulation be impacted by remedial actions. Given the location of Sudbury Annex within several towns and communities, particular attention should be paid to these requirements and their potential applicability.

REFERENCES

Aneptek. Aneptek Corporation. 1991. Endangered Species Survey - Phase I An Environmental Inventory of Wildlife Species and Their Habitats, Final Report. Contract No. DAAK6091P2517. Aneptek Corporation, Natick, MA.

EEI. Ecology and Environment, Inc. 1993. Master Environmental Plan - Fort Devens Sudbury Training Annex, Massachusetts. Contract No. DAAA15-90-D-0012. Ecology and Environment, Inc., Arlington, VA.

Foster, D. 1994. State Geologist, Executive Office of Environmental Affairs, Boston, MA. Personal communication, February 7, 1994 (617-727-9800).

Oldale, R. 1993. Geologist, Geologic Division, Woods Hole, MA. Personal communication, June 4, 1993.

Sinnott, J. 1992. State Geologist, Executive Office of Environmental Affairs, Boston, MA. Personal communication, April 16, 1992 (617-727-9800, ext. 213).

USEPA. United States Environmental Protection Agency. 1988. CERCLA Compliance With Other Laws, Draft Guidance. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

USEPA. United State Environmental Protection Agency. 1989. CERLCA Compliance With Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

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U.S. ARMY ENVIRONMENTAL CENTER

ASSESSMENT OF CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FORT DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 23, 1994

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ASSESSMENT OF CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FT. DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 23, 1994

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ASSESSMENT OF CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR THE FORT DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

1. INTRODUCTION

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) was passed by Congress and signed into law on December 11, 1980 (Public Law 96-510). This act was intended to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites." The Superfund Amendments and Reauthorization Act (SARA), adopted on October 17, 1986 (Public Law 99-499), did not substantially alter the original structure of CERCLA but provided extensive amendments to it.

In particular, Title I, § 121 of SARA specifies that for any hazardous substance, pollutant, or contaminant that remains on-site, the level or standard of control that must be met shall be at least that of any legally applicable or relevant and appropriate regulation (ARAR), standard, criteria, or limitation under any federal environmental law or any more stringent standard promulgated under state environmental or facility siting law. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

The U.S. Army Environmental Center (USAEC) has asked the support of the Chemical Hazard Evaluation Group in the Health and Safety Research Division at Oak Ridge National Laboratory (ORNL) for assistance in determining chemical-specific ARARs for the Fort Devens Sudbury Training Annex (the Annex), Middlesex County, Massachusetts. The Annex was proposed for listing on the National Priorities List (NPL) in 1989 (54 FR 29820, July 14, 1989) and finalized in 1990 (55 FR 6154, February 21, 1990). The support document used in the preparation of this document is the Draft Master Environmental Plan (EEI 1993).

The following is a listing of the definitions of terms used throughout this report:

Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" [40 CFR § 300.5 (1991)].

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" [40 CFR § 300.5 (1991)].

Requirements under federal or state law may be *either* applicable *or* relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be *both* relevant *and* appropriate for compliance to be necessary. In the case where a federal and a state ARAR are available, or where there are two potential ARARs addressing the same issue, the more stringent regulation must be selected. However, CERCLA §121(d)(4) provides several ARAR waiver options that may be invoked, providing that the basic premise of protection of human health and the environment is not ignored. A waiver is available for state standards that have not been applied uniformly in similar circumstances across the state.

CERCLA on-site remedial response actions must only comply with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA §121(e) and FFA §XXII]. To ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final NCP (55 Fed. Reg. 8756, March 8, 1990). **Substantive requirements** pertain directly to the actions or conditions at a site, while **administrative requirements** facilitate their implementation. EPA recognizes that certain of the administrative requirements such as consultation with state agencies, reporting, etc., are accomplished through the state involvement and public participation requirements of the NCP. These administrative requirements should be observed if they are useful in determining cleanup standards at the site.

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs but are **"to-be-considered" (TBC)** guidance [40 CFR 300.400(g)(3)(1991)].

Selection of ARARs is dependent on the hazardous substances present at the site, the site characteristics and location, and the actions selected for a remedy. Thus, these requirements may be chemical-, location-, or action-specific. Chemical-specific ARARs are health- or risk-based concentration limits set for specific hazardous substances, pollutants, or contaminants. Location-specific ARARs address such circumstances as the presence of an endangered species on the site or the location of the site in a 100-year floodplain. Location-specific ARARs are being provided under separate cover. Action-specific ARARs control or restrict particular types of remedial actions selected as alternatives for cleanup of the site. Action-specific ARARs will be determined when remedial alternatives are selected during the Feasibility Study.

The Annex encompasses 2,750 acres and is located in Middlesex County, Massachusetts, 20 miles west of Boston. Portions of the towns of Maynard, Hudson, Marlboro, Stow, and Sudbury are within the boundaries of the installation. The Annex has served several uses including ammunition storage; ordnance research and development; laboratory research; equipment field testing; railroad operations; troop training; and disposal of cloth, food, and chemicals. Potential contaminants are explosives; solvents; pesticides and herbicides; polychlorinated biphenyls (PCBs); heavy metals; and petroleum fuels, oils and lubricants (EEI 1993). Past site assessments and remedial investigations identified 68 sites as potential areas of contamination. Feasibility studies are currently being conducted by OHM Corporation on three of the sites (A4, A7/P8, A9/P12). Twenty-eight of the sites are being

proposed for no further action. Site investigations/remedial investigations (SI/RI) are being conducted by Ecology and Environment, Inc. (E&E) on two of the sites (P11 and P37) and SIs are being conducted for 36 sites. This report will provide chemical-specific ARARs for all chemicals detected at the E&E sites. The sites have been grouped according to watersheds: Watershed 1A - Taylor Brook above Honey Brook; Watershed 1B - Taylor Brook below Honey Brook; Watershed 2 - Hop Brook Drainage; Watershed 3 - Unnamed tributary 1 to Assabet River (North End); Watershed 4 - unnamed tributary 2 to Assabet River (Northwest End); Watershed 5 - Boons Pond Drainage; and Watershed 6 - Run Brook (Willis Pond) Drainage.

The Annex is located near the western boundary of the Seaboard Lowland Section of the New England-Maritime physiographic province. The installation is located within the Eastern White Pine and Scarlet Oak forest cover types. Lowland areas, including bogs, marshes, and swamps, occur throughout the installation. The depth to the water table is less than 15 feet, with groundwater occurring mostly in the outwash plain underlying the lowlands. Groundwater flow in the glacial aquifers is controlled by surface geology and discharge to surface water bodies. Groundwater yields in the impermeable till or bedrock is low. On-site surface waters flow into the Assabet River, which is in the Concord River Basin. Most of the northern section of the Annex drains northward towards Taylor Brook and its associated tributaries, which eventually drain into the Assabet River. Honey Brook, which drains into Taylor Brook, originates in the western section of the installation. The southwestern and western sections of the Annex drain into either White Pond or Lake Boon, which discharge to the Assabet River. White Pond, which is used as a source of water supply for the town of Maynard, drains underground into Lake Boon. The remainder of the Annex drains into Hop Brook or it tributaries (Run Brook and Marlboro Brook). Hop Brook discharges to the Sudbury River prior to its confluence with the Assabet River (EEI 1993).

2. CHEMICAL-SPECIFIC ARARs

This report provides available chemical-specific ARARs or "to be considered" (TBC) guidance values to set protective cleanup levels for all chemicals detected in the designated media at the E&E sites or else indicate a safe level of discharge that may be incorporated when considering a specific remedial activity.

2.1. Federal and State ARARs

2.1.1. Drinking Water and Groundwater

In the final National Contingency Plan (NCP), EPA states a preference for Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and non-zero maximum contaminant level goals (MCLGs) or other health-based standards, criteria, or guidance for cleanup of Class I and II groundwater at CERCLA sites (55 FR 8732). The goal of EPA's approach to clean up contaminated groundwater is to return usable groundwater to its beneficial use within a given time frame that is reasonable given the particular circumstances at a CERCLA site. Although not an ARAR unless promulgated, the EPA guidance on

groundwater classification should be used to help in determining whether groundwater at a site falls within Class I, II or III. Classes I and IIA represent current sources of drinking water of varying value; Class IIB represents potential sources of drinking water; and Class III groundwater is not considered to be a potential source of drinking water and is of limited beneficial use. Restoration time periods vary depending on the use classification of the groundwater and may range from one year to several decades. Aquifers in certain areas of the Annex are used for drinking water supplies and certain areas of groundwater are classified by the Massachusetts Division of Water Supply as Zone II, which is a defined area of groundwater that contributes water to pumped wells with an approved capacity of >100,000 gallons/day (Blain 1994). Three public water supply wells in the Sudbury Water District (Wells #3, 8, and 10) are located within the Annex boundaries just north of Willis Pond. A public water supply well for the Maynard Public Works Department - Water Division (Well #3) is located within the Annex boundaries north of Puffer Pond. White Pond, located just south of the Annex boundary, serves as a public water supply for the town of Hudson. In addition, the Massachusetts Bureau of Waste Site Cleanup's Priority Resource Map for this area indicates areas of medium to high yield aquifers, particularly on the western side of the installation (Blain 1994). Consequently, certain areas of groundwater underlying the Annex would be classified by EPA's approach as Class I and IIA and certain areas of groundwater could be considered potential sources of drinking water or Class IIB. There is also the potential that other areas of groundwater may be unsuitable for water supply but may discharge to surface water bodies.

Although limited in number, chemical-specific standards pertaining to water quality have been established under the SDWA in 40 CFR 141 as National Primary Drinking Water Standards (NPDWS). These regulations are applicable to public water systems that have at least 15 service connections or serve an average of at least 25 people daily at least 60 days of the year. NPDWS include MCLs and MCLGs. The MCLs are enforceable standards that take into consideration human health effects, available treatment technologies, and costs of treatment. MCLs would be legally applicable to remediation of any Zone II groundwater or of groundwater that serves a public water supply well at the Annex. These MCLs would also be relevant and appropriate requirements for remediation of medium to high yield areas of groundwater that could be a potential source of drinking water supply. MCLGs are strictly health-based standards that disregard cost or treatment feasibility and are not legally enforceable, but would be relevant and appropriate for cleanup of groundwater at the Annex. Table 1 lists SDWA MCLs and MCLGs for the detected chemicals in groundwater at the Annex. Pursuant to the SDWA amendments of 1986, EPA has promulgated MCLs for fluoride (51 FR 11396, April 2, 1986, effective October 2, 1987); for benzene, 1,1-dichloroethylene, 1,1,1-trichloroethane, and trichloroethylene (52 FR 25690, July 8, 1987, effective January 9, 1989); for cadmium, chlordane, chlorobenzene, chromium, ethylbenzene, heptachlor, heptachlor epoxide, lindane, mercury, nitrate, polychlorinated biphenyls, selenium, tetrachloroethylene, toluene, and xylene (56 FR 3526, January 30, 1991, effective July 30, 1992); for barium (56 FR 30266, July 1, 1991, effective January 1, 1993); and for antimony, beryllium, endrin, methylene chloride, nickel, (57 FR 31776, July 17,1992, effective August 17, 1992).

The Commonwealth of Massachusetts has adopted Drinking Water Standards and Guidelines, expressed in terms of maximum levels of contaminants allowable in drinking

Table 1. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Groundwater Used as Drinking Water Supply at the E&E Sites at Sudbury Training Annex[a]

Chemical	Applicable			Relevant and Appropriate			TBC Guidance[b]			
	SDWA[c] MCL[d]	MMCL[e]	MA Groundwater Standard[f]	SDWA MCLGs[g]	MA SMCLs[h]	SDWA Action Level[i]	SDWA SMCL[j]	Drinking Water HA[k]	SDWA NIPDWR/ Proposed MCL[l]	MA ORSG[m]
Acetone			3,000							3,000
Alcohols (high molecular weight)										
Aluminum					50/200		50/200			
2-Amino-4,6-dinitrotoluene										
4-Amino-2,6-dinitrotoluene										
Antimony	6		6	6				3		6
Arsenic		50	50					0.02[n]	50	
Barium	2,000	2,000		2,000				2,000		
Benzene	5	5	5	0				1[n]		
Beryllium	4		4	0				0.008[n]		4
α-BHC										
Bicyclohexyl										
2-Butanone										
Cadmium	5	5	5	5				5		
Calcium										
Carbon disulfide										
α-Chlordane	2	5	5	0				0.03[n]		
Chlorobenzene	100	100	100					100		
Chlorodifluoromethane										
Chloroform		100[o]	5					6[n]	100[o]	5

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Chloromethane								3		
Chromium (IV)			50							
Chromium (Total)	100	100	100	100				100		
Cobalt										
Copper		1,300		1,300	1,000	1,300	1,000			
Cyclohexanol										
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX								2		
Dacthal/DCPA								4,000		
p,p-DDD			0.1							
p,p-DDT			0.3							
1,3-Dichlorobenzene			600					600		
1,1-Dichloroethylene	7	7	7	7				7		
Dieldrin			0.1					0.002[n]		
N,N-Diethyl-3-methylbenzamide										
Dimethoxy dimethylsilane										
1,3-Dimethylbenzene/m-xylene										
1,4-Dimethylbenzene										
2,4-Dinitrotoluene			30							
Dioctyl adipate										
Endosulfan, B			0.4							

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Endrin	2	2	2	2				2		
Endrin aldehyde										
Ethylbenzene	700	700	700	700				700		
Ethyl methyl benzene										
1-Ethyl-2-methylbenzene										
Heptachlor	0.4	0.4	0.4	0				0.008[n]		
Heptachor epoxide	0.2	0.2	0.2	0				0.004[n]		
Hexamethylcyclotrisiloxane										
2-Hexanone										
Hydrocarbons (all molecular weights)										
4-Hydroxyl-4-methyl-2-pentanone										
Indan/Hydrindene										
Iron					300		300			
Lead		15	15	0		15				
Lindane	0.2	0.2	0.2	0.2				0.2		
Magnesium										
Manganese					50					
Mercury	2	2	2	2				2		
2-Methoxy-1-propene										
Methylene chloride	5		5	0						

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Chemical	Applicable			Relevant and Appropriate			TBC Guidance[b]			
	SDWA[c] MCL[d]	MMCL[e]	MA Groundwater Standard[f]	SDWA MCLGs[g]	MA SMCLs[h]	SDWA Action Level[i]	SDWA SMCL[j]	Drinking Water HA[k]	SDWA NIPDWR/ Proposed MCL[l]	MA ORSG[m]
1-Methylindan										
Methylisobutyl ketone			350							350
1-Methylnaphthalene										
2-Methylnaphthalene			10							
Naphthalene			20					20		
Nickel	100		100	100				100		100
Nitrate	10,000	10,000		10,000						
Nitrobenzene										
Nitroglycerine										
2-Nitrotoluene										
3-Nitrotoluene										
4-Nitrotoluene										
Oil and grease										
PCB-1254	0.5	0.5	0.5	0				0.005[n]		
Pentaerythritol tetranitrate/PETN										
Phosphate										
Potassium										
Selenium	50	50	50	50						
Silver			40		100		100	100		
Sodium								20,000[k]		28,000

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Sulfate					<u>250,000</u>		250,000		400,000/ 500,000	
Sulfur										
Supraene/spinacene/squalene										
Tetrachloroethylene/ tetrachloroethene	<u>5</u>	5	5	0				0.7[n]		
Tetrahydrofuran										<u>1,300</u>
1,2,3,4-Tetramethylbenzene										
Toluene	<u>1,000</u>	1,000	1,000	1,000				1,000		
Total petroleum hydrocarbons			<u>1,000</u>							
1,1,1-Trichloroethane	<u>200</u>	200	200	200				200		
Trichloroethylene/Trichloroethene	<u>5</u>[q]	5	5	0				3[n]		
1,2,3-Trimethylbenzene										
Trimethylbenzenes										
1,3,5-Trinitrobenzene										
2,4,6-Trinitrotoluene								<u>2</u>		
Vanadium										
Xylene	<u>10,000</u>	10,000	10,000	10,000				10,000		
Zinc			<u>2,000</u>		5,000		5,000	2,000		

[a] This table provides ARARs or TBC guidance for all chemical historically detected in groundwater at Sudbury Training Annex (based on monitoring data from USAEC Installation Restoration Database Management Information System, as of December 21, 1993). The underlined values indicate the ARAR or TBC for each chemical. The

applicable requirements (SDWA MCLs and MMCLs) would also be relevant and appropriate requirements for remediation of the medium to high yield areas of groundwater underlying the Annex.

[b] TBC = "To be considered" guidance.

[c] SDWA = Safe Drinking Water Act.

[d] MCL = Maximum Contaminant Level. 52 FR 25690 (July 8, 1987); 56 FR 3526 (January 30, 1991); 56 FR 30266 (July 1, 1991); 57 FR 31776 (July 17, 1992).

[e] Code of Massachusetts Regulations, Title 310, Section 22, Drinking Water Regulations, effective November 20, 1992.

[f] Code of Massachusetts Regulations, Title 310, Section 40.0974(2), Groundwater Standards for category GW-1 July 30, 1993, effective October 1, 1993.

[g] MCLG = Maximum Contaminant Level Goal.

[h] SMCL = Secondary Maximum Contaminant Level, Code of Massachusetts Regulations, Title 310, Section 22, effective November 20, 1992.

[i] Established as an action level/MCLG, 56 FR 26460 (June 7, 1991), effective December 7, 1992.

[j] National Secondary Drinking Water Standards designed to protect the aesthetic quality of water (44 FR 42198, July 19, 1979; 51 FR 11396, April 2, 1986; 56 FR 3526, January 30, 1991).

[k] USEPA Office of Water Lifetime Health Advisories (HA), May 1993. The value for sodium is a Drinking Water Equivalent Level guidance value.

[l] NIPDWR = National Interim Primary Drinking Water Regulation. NIPDWR for arsenic - 40 FR 59570 (December 24, 1975), Notice of Proposed Rulemaking expected September 1994, Final rule expected September 1996. Proposed MCL for sulfates - 55 FR 303070, September 25, 1990, EPA has deferred setting final standard pending further study (57 FR 31776, July 17, 1992).

[m] ORSG = Office of Research and Standard Guidelines, Massachusetts Department of Environmental Protection, Spring 1993. The ORSG for chloroform is for non-chlorinated water supplies.

[n] USEPA Office of Water Health Advisory representing a 10^{-6} cancer risk, the concentration in drinking water that will result in one excess cancer death in one million people.

[o] These values are for Total Trihalomethanes, which is the sum of the concentration of chloroform, bromodichloromethane, dibromochloromethane, and bromoform. NIPDWR 40 FR 59570 (December 24, 1975), effective June 24, 1976.groundwater classification should be used to help in determining whether groundwater at a site falls within Class I, II or III. Classes I and IIA represent current sources of drinking water of varying value; Class IIB represents potential sources of drinking water; and Class III groundwater is not considered to be a potential source of drinking water and is of limited beneficial use. Restoration time periods vary depending on the use classification of the groundwater and may range from one year to several decades. Aquifers in certain areas of the Annex are used for drinking water supplies and certain areas of groundwater are classified by the Massachusetts Division of Water Supply as Zone II, which is a defined area of groundwater that contributes water to pumped wells with an approved capacity of > 100,000 gallons/day (Blain 1994). Three public water supply wells in the Sudbury Water District (Wells #3, 8, and 10) are located within the Annex boundaries just north of Willis Pond. A public water supply well for the Maynard Public Works Department - Water Division (Well #3) is located within the Annex boundaries north of Puffer Pond. White Pond, located just south of the Annex boundary, serves as a public water supply for the town of Hudson. In addition, the Massachusetts Bureau of Waste Site Cleanup's Priority Resource Map for this area indicates areas of medium to high yield aquifers, particularly on the western side of the installation (Blain 1994). Consequently, certain areas of groundwater underlying the Annex would be classified by EPA's approach as Class I and IIA and certain areas of groundwater could be considered potential sources of drinking water or Class IIB. There is also the potential that other areas of groundwater may be unsuitable for water supply but may discharge to surface water bodies.

Although limited in number, chemical-specific standards pertaining to water quality have been established under the SDWA in 40 CFR 141 as National Primary Drinking Water Standards (NPDWS). These regulations are applicable to public water systems that have at least 15 service connections or serve an average of at least 25 people daily at least 60 days of the year. NPDWS include MCLs and MCLGs. The MCLs are enforceable standards that take into consideration human health effects, available treatment technologies, and costs of treatment. MCLs would be legally applicable to remediation of any Zone II groundwater or of groundwater that serves a public water supply well at the Annex. These MCLs would also be relevant and appropriate requirements for remediation of medium to high yield areas of groundwater that could be a potential source of drinking water supply. MCLGs are strictly health-based standards that disregard cost or treatment feasibility and are not legally enforceable, but would be relevant and appropriate for cleanup of groundwater at the Annex. Table 1 lists SDWA MCLs and MCLGs for the detected chemicals in groundwater at the Annex. Pursuant to the SDWA amendments of 1986, EPA has promulgated MCLs for fluoride (51 FR 11396, April 2, 1986, effective October 2, 1987); for benzene, 1,1-dichloroethylene, 1,1,1-trichloroethane, and trichloroethylene (52 FR 25690, July 8, 1987, effective January 9, 1989); for cadmium, chlordane, chlorobenzene, chromium, ethylbenzene, heptachlor, heptachlor epoxide, lindane, mercury, nitrate, polychlorinated biphenyls, selenium, tetrachloroethylene, toluene, and xylene (56 FR 3526, January 30, 1991, effective July 30, 1992); for barium (56 FR 30266, July 1, 1991, effective January 1, 1993); and for antimony, beryllium, endrin, methylene chloride, nickel, (57 FR 31776, July 17,1992, effective August 17, 1992).

water. The Commonwealth lists its Maximum Contaminant Levels (MMCLs) in Section 22, Drinking Water Regulations, Code of Massachusetts Regulations, Title 310 (310 CMR 22.05 to 22.09), effective November 20, 1992. The Division of Water Supply is the enforcement authority. The MMCLs are also listed in Table 1 as applicable requirements for cleanup of Zone II groundwater and of groundwater that serves a public water supply well at the Annex. As with the SDWA MCLs, the MMCLs would also be relevant and appropriate requirements for remediation of the medium to high yield groundwater that could be a potential source of drinking water supply. The MMCLs are identical to the SDWA MCLs, with the exception of chlordane for which the SDWA MCL of 2 μg/L is stricter than the MMCL of 5 μg/L; consequently the SDWA MCL would be the applicable requirement (see Table 1).

The Commonwealth of Massachusetts has also established Groundwater Standards in the Massachusetts Contingency Plan (310 CMR 40, July 30, 1993, effective October 1, 1993), promulgated pursuant to Massachusetts General Law c. 21E. These standards apply to the cleanup of disposal sites and are developed using a Method 1 risk characterization approach (310 CMR 40.0970), which compares the current and reasonably foreseeable use of the groundwater at the disposal site to promulgated standards (MMCLs in 310 CMR 22; Groundwater Quality Standards in 314 CMR 6). The groundwater category (GW-1, GW-2, GW-3) identified for the site determines which standards apply. Category GW-1 groundwater is defined as groundwater within a Zone II; within a Wellhead Protection Area; within a potentially productive area; within Zone A of a Class A surface water body; within 500 feet or more of a public water system distribution pipeline; or within 500 feet of a private water supply well that is in compliance with pertinent regulations. Based on these definitions in 310 CMR 40.0932, certain areas of groundwater at the Annex would be in Category GW-1 established by the Department of Environmental Protections's Division of Water Supply, pursuant to 310 CMR 22.02. Consequently, the MCP Method 1 Groundwater Standards provided in the GW-1 column of 310 CMR 40.0974(2) and in Table 1 of this document will be considered applicable requirements for cleanup of these areas of contaminated groundwater at the Annex. GW-3 Groundwater Standards would be applicable requirements for the remediation of groundwater underlying the Annex that potentially discharges to surface waters and that is not a current or potential source of drinking water. These standards are presented in Table 2 for all of the detected chemicals in groundwater at the Annex. The GW-1 Groundwater Standards are identical to the SDWA MCLs and/or MMCLs for several of the chemicals detected at the Annex (see Table 1). The Commonwealth of Massachusetts has also established MCP Method 1 Groundwater Standards for chemicals for which a SDWA MCL or MMCL has not been promulgated, including acetone, chloroform, chromium VI, DDD, DDT, 1,3-dichlorobenzene, dieldrin, 2,4-dinitrotoluene, endosulfan B, methyl isobutyl ketone, 2-methylnaphthalene, naphthalene, silver, total petroleum hydrocarbons, and zinc. These standards would be ARAR for cleanup of these chemicals in groundwater used as drinking water at the site (see Table 1). According to 310 CMR 40.0983, if an MCP Method 1 Groundwater Standard has not been promulgated by the Department, a Licensed Site Professional may develop an MCP Method 2 Standard for the chemical, based on either background concentrations, non-cancer or cancer risk, or the Practical Quantitation Limit. The non-cancer health risk would be a

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex	
Chemical	MA Groundwater Standard GW-3[a]
Acetone	50,000
Alcohols (high molecular weight)	
Aluminum	
2-Amino-4,6-dinitrotoluene	
4-Amino-2,6-dinitrotoluene	
Antimony	300
Arsenic	400
Barium	
Benzene	7,000
Beryllium	50
α-BHC	
Bicyclohexyl	
2-Butanone	
Cadmium	10
Calcium	
Carbon disulfide	
α-Chlordane	2
Chlorobenzene	500
Chlorodifluoromethane	
Chloroform	10,000
Chloromethane	
Chromium (IV)	100
Chromium (Total)	2,000
Cobalt	
Copper	
Cyclohexanol	
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX	
Dacthal/DCPA	
p,p-DDD	6

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex	
Chemical	MA Groundwater Standard GW-3[a]
p,p-DDT	0.3
1,3-Dichlorobenzene	8,000
1,1-Dichloroethene	50,000
Dieldrin	0.1
N,N-Diethyl-3-methylbenzamide	
Dimethoxy dimethylsilane	
1,3-Dimethylbenzene/m-xylene	
1,4-Dimethylbenzene	
2,4-Dinitrotoluene	2,000
Dioctyl adipate	
Endosulfan, B	0.1
Endrin	5
Endrin aldehyde	
Ethylbenzene	4,000
Ethyl methyl benzene	
1-Ethyl-2-methylbenzene	
Heptachlor	1
Heptachor epoxide	2
Hexamethylcyclotrisiloxane	
2-Hexanone	
Hydrocarbons (all molecular weights)	
4-Hydroxyl-4-methyl-2-pentanone	
Indan/Hydrindene	
Iron	
Lead	30
Lindane	0.8
Magnesium	
Manganese	
Mercury	1
2-Methoxy-1-propene	

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex	
Chemical	MA Groundwater Standard GW-3[a]
Methylene chloride	50,000
1-Methylindan	
Methyl isobutyl ketone	50,000
1-Methylnaphthalene	
2-Methylnaphthalene	3,000
Naphthalene	6,000
Nickel	80
Nitrate	
Nitrobenzene	
Nitroglycerine	
2-Nitrotoluene	
3-Nitrotoluene	
4-Nitrotoluene	
Oil and grease	
PCB-1254	0.3
Pentaerythritol tetranitrate/PETN	
Phosphate	
Potassium	
Selenium	80
Silver	7
Sodium	
Sulfate	
Sulfur	
Supraene/spinacene/squalene	
Tetrachloroethylene/tetrachloroethene	5,000
Tetrahydrofuran	
1,2,3,4-Tetramethylbenzene	
Toluene	50,000
Total petroleum hydrocarbons	50,000
1,1,1-Trichloroethane	50,000

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex	
Chemical	MA Groundwater Standard GW-3[a]
Trichloroethylene/Trichloroethene	20,000
1,2,3-Trimethylbenzene	
Trimethylbenzenes	
1,3,5-Trinitrobenzene	
2,4,6-Trinitrotoluene	
Vanadium	
Xylene (total)	50,000
Zinc	900

[a] Code of Massachusetts Regulations, Title 310, Section 40.0974(2), Groundwater Standards for category GW-3 July 30, 1993, effective October 1, 1993.

concentration in drinking water of the chemical associated with 20% of an allowable daily dose. The cancer risk value would be the concentration of the chemical associated with an excess lifetime cancer risk of 10^{-6}.

The Commonwealth of Massachusetts has established MMCLs and Groundwater Standards of 15 μg/L and 50 μg/L for lead and arsenic, respectively, and an MMCL of 1,300 μg/L for copper. USEPA, under the SDWA, has promulgated action levels for lead and copper that are identical to the MMCLs and/or Groundwater Standard. The federal action levels are relevant and appropriate requirements for Superfund sites with contaminated groundwater. The MMCL for lead would be the applicable requirement for Zone II groundwater and for groundwater that serves a public water supply well. Massachusetts has also promulgated a stricter secondary MCL (SMCL) for copper of 1,000 μg/L that would be relevant and appropriate for groundwater cleanup at the site. Consequently, based on strictness, the SMCL would be the selected ARAR. Exceedance of the SDWA action levels indicates potential source water (groundwater) contamination and triggers the need to implement either optimal corrosion control for systems serving <50,000 people or source water monitoring and possible treatment, public education, and lead service line replacement for all systems. It is not equivalent to an MCL but is a treatment technique requirement. Upon exceedance, the water system is required to collect source water samples and submit the results to the Commonwealth of Massachusetts. Within six months of exceeding the action level, the water system is required to recommend in writing to the Commonwealth a proposed source water treatment. The Commonwealth of Massachusetts would then be required to analyze the monitoring results and treatment recommendation to determine the technology that would be most effective at reducing contaminant levels in water delivered to the user's tap. Follow-up source water and tap samples are to be taken within 12 months of the installation of the treatment and submitted to the Commonwealth. The Commonwealth will then establish maximum permissible lead levels in source water that the water system must maintain.

National Secondary Drinking Water Regulations have also been established under the SDWA in 40 CFR Part 143. The secondary standards are known as SMCLs, and are levels established to regulate the aesthetic qualities related to public acceptance of drinking water. The federal regulations are not enforceable but rather are intended to serve as guidelines for use by states. Therefore, they are not considered as potential ARARs but are listed in Table 1 as "to-be-considered" guidance. Massachusetts SMCLs that have been promulgated, pursuant to 310 CMR Section 22 (effective November 20, 1992) are legally enforceable and are relevant and appropriate for cleanup of groundwater at the Annex. The Massachusetts SMCLs for aluminum, iron, manganese, and sulfates would be relevant and appropriate requirements for cleanup of groundwater at the Annex (see Table 1).

2.1.2. Surface Water and Sediment

CERCLA §121(d)(2)(A) specifically states that remedial actions shall at least attain federal ambient water quality criteria (WQC) established under the Clean Water Act (CWA) if they are relevant and appropriate. In determining whether any WQC are relevant and appropriate, one must consider the "designated or potential use of the surface water, the environmental media affected, the purposes for which the criteria were developed, and the latest information available" [CERCLA §121(d)(2)(B)]. Federal WQC are derived for the protection of human

Table 3. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Surface Water at the E&E Sites at Sudbury Training Annex[a]

Chemical	Massachusetts/CWA WQC for Protection of Human Health[b]		Massachusetts/CWA WQC for Protection of Aquatic Organisms[c]	
	Consumption of Aquatic Organisms and Drinking Water[d]	Consumption of Aquatic Organisms Only[d]	Freshwater Acute[e]	Freshwater Chronic[f]
Acetone				
Aluminum				
Arsenic	0(0.018)	0(0.14)	360	190
Barium				
2-Butanone				
2-(2-N-Butoxyethoxy)ethanol				
Calcium				
Carbonic acid dimethyl ether				
Chromium				
Chromium (IV)			16	11
Copper			18[g]	12[g]
Dacthal/DCPA				
p,p-DDD	0(0.00059)	0(0.00059)		
p,p-DDE	0(0.00083)	0(0.00084)		
Dimethoxy dimethylsilane				
Dioctyl adipate				
2E1HXL				
Endosulfan sulfate	0.93	2.0		
Endrin	0.76	0.81	0.18	0.0023
Hexadecanoic acid/Palmitic acid				
Hexamethylcyclotrisiloxane				

Table 3. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Surface Water at the E&E Sites at Sudbury Training Annex[a]

Chemical	Massachusetts/CWA WQC for Protection of Human Health[b]		Massachusetts/CWA WQC for Protection of Aquatic Organisms[c]	
	Consumption of Aquatic Organisms and Drinking Water[d]	Consumption of Aquatic Organisms Only[d]	Freshwater Acute[e]	Freshwater Chronic[f]
Hydrocarbons (all molecular weights)				
4-Hydroxy-4-methyl-2-pentanone				
Iron				
Lead			82[g]	3.2[g]
Magnesium				
Manganese				
2-(2-Methoxyethoxy)ethanol				
Methylene chloride	0(4.7)	0(1600)		
3-Nitrotoluene				
Oil and grease[h]				
Phenol	21,000	4,600,000		
Phenoxyacetic acid				
2-Phenoxyethanol				
2-(2-N-Phenoxyethoxy)ethanol				
Phosphate				
Potassium				
Selenium			20	5
Silver			4.1[g]	
Sodium				
Sulfur				
1,1,2,2-Tetrachloroethane	0(0.17)	0(11)		

Table 3. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Surface Water at the E&E Sites at Sudbury Training Annex[a]

Chemical	Massachusetts/CWA WQC for Protection of Human Health[b]		Massachusetts/CWA WQC for Protection of Aquatic Organisms[c]	
	Consumption of Aquatic Organisms and Drinking Water[d]	Consumption of Aquatic Organisms Only[d]	Freshwater Acute[e]	Freshwater Chronic[f]
Tetracosane				
Toluene	<u>6800</u>	200,000		
1,1,2-Trichloroethane	0(<u>0.60</u>)	0(42)		
2,2,4-Trimethyl-1,3-pentanediol				
Vanadium				
Xylene				
Zinc			120[g]	<u>110</u>[g]

[a] This table provides ARARs for all chemicals historically detected in surface water at Group IB site, Fort Devens (based on monitoring data from USAEC Installation Restoration Database Management Information System, Inc. as of December 21, 1993). All values in this table are given in $\mu g/L$. The underlined values indicate the strictest ARAR for each chemical.
[b] WQC = Water Quality Criteria from Code of Massachusetts Regulation, Title 314, Section 4.05(5)(e)/U.S. Environmental Protection Agency, 57 FR 60848, December 22, 1992.
[c] WQC = Water Quality Criteria from Code of Massachusetts Regulation, Title 314, Section 4.05(5)(e)/U.S. Environmental Protection Agency, 57 FR 60848, December 22, 1992.
[d] The criterion value of zero for all potential carcinogens is listed in the table. Concentrations in parentheses for potential caricnogens correspond to a risk of 10^{-6}.
[e] One-hour average concentration not to be exceeded more than once every 3 years.
[f] Four-hour average concentration not to be exceeded more than once every 3 years.
[g] Water hardness dependent criteria (100 mg/L as $CaCO_3$).
[h] See Section 2.1.2. of the text for the Commonwealth narrative criterion.

health from the consumption of contaminated drinking water and/or aquatic organisms and for the protection of freshwater aquatic organisms. The Code of Massachusetts Regulations, Title 314, Chapter 4, Surface Water Quality Standards, effective February 28, 1992, classifies the surface waters of the Commonwealth according to the uses of those waters. Chapter 4 also prescribes the water quality criteria necessary to achieve those classifications and specifies other policies, including the prohibition of discharges to those waters where necessary. The Annex lies within the Concord River Basin which has a Class B Waterway classification. Taylor Brook, Honey Brook, Marlboro Brook, and other unnamed streams and tributaries flow through the Annex discharging either directly or indirectly into the Assabet or Concord Rivers. Both of these rivers are Class B waters. The northern portion of the Annex flows directly to the Assabet River via Taylor Brook and its tributaries. The southwestern and western sides of the Annex drain primarily into Lake Boon or White Pond, located outside the southwest boundary of the Annex, which, in turn, discharges into the Assabet River. White Pond is listed as a Class A water in Table 23 of Chapter 4 of the Code. None of the sites of concern for this document drain into White Pond. The detached south portion of the Annex drains into Hop Brook, which discharges into the Concord River. Puffer Pond, Willis Pond, Cutting Pond, and Vose Pond are located within the boundaries of the Annex (EEI 1993). Because none of these ponds are listed in Table 23 of Chapter 4 of the Code, they are automatically classified as Class B waters (Hogan 1992). Class B waters are designated as habitat for fish, other aquatic and wildlife, and for primary and secondary contact recreation. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value [314 CMR 4.05(3)(b)]. The state surface water minimum criteria for Class B waters are consistent with the federal WQC (Hogan 1992). The other state criteria are narrative except for those pollutants that have prescribed minimum water quality criteria established by EPA pursuant to Section 304(a) of the federal Clean Water Act [314 CMR 4.05(5)(e)], and except where a site-specific limit is established pursuant to 314 CMR 4.05(5)(e)(1-4). The Commonwealth narrative criterion for oil and grease states that Class B waters "shall be free from oil, grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course, or are deleterious or become toxic to aquatic life" [314 CMR 4.05(3)(b)(5)].

Table 3 lists Massachusetts and federal CWA WQC for the protection of human health for the consumption of aquatic organisms and drinking water and for the consumption of aquatic organisms alone and Massachusetts and federal CWA WQC for the protection of aquatic organisms, acute and chronic for the chemicals detected in surface waters at the Annex. The Massachusetts WQC would be considered applicable for the remediation of contamination in the on-site surface water bodies of the Concord River Basin; the CWA WQC are relevant and appropriate requirements for remediation of these water bodies.

Massachusetts also includes antidegradation provisions for surface waters, codified at 314 CMR 4.04 (1990). The regulation requires the protection of existing uses and states that "In all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." The policy is an anti-pollution requirement rather than a cleanup requirement and would not be considered a chemical-specific ARAR. In addition, it would not the policy itself that would be ARAR but the standards that are promulgated to carry out the policy that would ARAR, the uses and associated criteria for specified water

bodies. Promulgation simply means that these standards have gone through rulemaking and public notice and comment.

There are no set maximum allowable residual levels for chemicals in sediments under federal or Massachusetts state law.

2.1.3. Soil

There are no set maximum allowable residual levels for chemicals in soils under federal law.

The Commonwealth of Massachusetts has established Soil Standards in the Massachusetts Contingency Plan (310 CMR 40, July 30, 1993, effective October 1, 1993), promulgated pursuant to Massachusetts General Law c. 21E. These standards apply to the cleanup of disposal sites and are developed using either a Method 1 (310 CMR 40.0975) or 2 (310 CMR 40.0985) risk characterization approach. MCP Method 1 involves the characterization of risk through the use of promulgated standards and considers the risk from direct exposure to the chemical in soil and the potential impacts on the groundwater through leaching. MCP Method 2 involves the application of site-specific methodologies and considers the risk from direct contact with the soil. The category of soil (S-1, S-2, S-3) at the exposure point determines the applicable Soil Standard. The soil categories are based on the potential for exposure, which involves the frequency of use, the intensity of use, and the accessibility for adults and/or children (310 CMR 40.0933). Table 4 provides the MCP Method 1 Soil Standards for GW-1 groundwater and all three soil categories and the MCP Method 2 Soil Standards for all three soil categories for the chemicals detected in soils at the E&E sites at the Annex. Table 5 provides the MCP Method 1 Soil Standards for GW-3 groundwater and all three soil categories and the MCP Method 2 Soil Standards for all three soil categories for these chemicals. 310 CMR 40.0933(9) provides a matrix to be used to identify the appropriate soil category for exposure potential. Based on the selected soil category, the values provided in Tables 4 or 5 would be considered applicable requirements for cleanup of contaminated soil at the Annex. According to 310 CMR 40.0984, if an MCP Method 1 Soil Standard has not been promulgated by the Department, a Potentially Responsible Party may develop an MCP Method 2 Standard for the chemical, based on several factors, including the background concentrations, non-cancer or cancer risk using the equations provided in the regulation, or the Practical Quantitation Limit. The non-cancer health risk would be a concentration in soil of the chemical associated with 20% of an allowable daily dose. The cancer risk value would be the concentration of the chemical associated with an excess lifetime cancer risk of 10^{-6}.

2.2. OTHER GUIDANCE TO BE CONSIDERED

2.2.1. Groundwater

Additional TBC guidance values are provided in Table 1 for any groundwater contaminant for which a final SDWA or Commonwealth MCL/MCLG, SMCL, or Groundwater Standard is yet to be promulgated. In the absence of federal- or state-promulgated ARARs, or in the case where ARARs are not adequately protective, EPA states a preference for Office of Drinking Water (ODW) Health Advisories (HAs), Reference Doses (RfDs) for systemic toxi

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Acenaphthene	20	20	20	1,000	2,500	5,000
Acetone	3	3	3	500	1,000	5,000
Alcohol (high molecular weight)						
Aldehydes						
Aluminum						
4-Amino-2,6-dinitrotoluene						
Anthracene	1,000	1,000	1,000	1,000	2,500	5,000
Antimony	10	40	40	10	40	40
Arsenic	30	30	30	30	30	30
Barium						
Benzo(a)anthracene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(a)pyrene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluorene						
Benzo(ghi)perylene	100	100	100	1,000	2,500	2,500
Benzo(e)pyrine						
Benzo(k)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(j)fluoranthene						
Beryllium	0.4	0.8	3	0.4	0.8	3
ß-BHC						
Δ-BHC						
2-Butanone						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Cadmium	30	80	80	30	80	80
Calcium						
Camphor						
Carbazole						
Carbonic acid dimethyl ether						
α-Chlordane						
μ-Chlordane						
Chlorobenzene	8	8	8	500	1,000	2,500
Chloroform	0.1	0.1	0.1	100	200	500
Chromium	1,000	2,500	5,000	1,000	2,500	5,000
Chrysene	0.7	0.7	0.7	0.7	0.7	0.7
Cobalt						
Copper						
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX						
Cyclotetramethylene-tetranitramine/HMX						
Dacthal/DCPA						
p,p-DDD	2	3	10	2	3	10
p,p-DDE	2	2	9	2	2	9
p,p-DDT	2	2	9	2	2	9
Dibenzofuran						
1,2-Dichloroethane	0.05	0.05	0.05	10	20	60

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Dieldrin	0.03	0.04	0.1	0.03	0.04	0.2
Diethyl phthalate	100	100	100	1,000	2,500	5,000
1,3-Dimethylcyclohexane						
1,4-Dimethylcyclohexane						
1,3-Dimethylbenzene/m-xylene						
1,5-Dimethylnaphthalene						
2,4-Dinitrotoluene						
2,6-Dinitrotoluene						
Dioctyl adipate						
Endosulfan, A and sulfate						
Endosulfan, B						
Endrin	0.6	0.6	0.6	6	10	10
Ethylbenzene	80	80	80	500	1,000	2,500
1-Ethyl-2-methylbenzene						
Fluoranthene	600	600	600	900	2,000	5,000
Fluorene	400	400	400	800	2,000	5,000
Heptachlor	0.1	0.2	0.7	0.1	0.2	0.7
Heptachlor epoxide	0.06	0.09	0.3	0.06	0.09	0.3
Heptacosane						
Heptadecane						
Hexachlorobiphenyls						
Hexadecane						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Hexadecanoic acid/Palmitic acid						
Hexamethylcyclotrisiloxane						
2,2,4,4,7,7-Hexamethyloctahydro-1H-indene						
2-Hexanone						
Hexatriacontane						
Hydrocarbons (all molecular weights)						
Indeno(1,2,3-cd)pyrene						
Iron						
Isophorone						
Lead	300	600	600	300	600	600
Lindane	0.1	0.1	0.1	0.4	0.6	2
Linoleic acid						
Magnesium						
Manganese						
Mercury	10	60	60	10	60	60
Mesityl oxide						
Methylene chloride	0.1	0.1	0.1	100	200	700
4-Methyl-1-(1-methylethyl)-bicyclo[3,1,0]hex-2-ene						
2-Methylnaphthalene	0.7	0.7	0.7	1,000	2,500	2,500
3-Methylpentane						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Naphthalene	4	4	4	100	2,500	2,500
Nickel	300	700	700	300	700	700
Nitroglycerine						
2-Nitrotoluene						
3-Nitrotoluene						
Nonane						
Octadecanoic acid/ stearic acid						
Octane						
Oil and grease						
PCB-1242	2	2	2	2	2	2
PCB-1248	2	2	2	2	2	2
PCB-1254	2	2	2	2	2	2
PCB-1260	2	2	2	2	2	2
2,2',4,4',5-Pentachloro-1,1'-biphenyl						
2,3',4,4',5-Pentachloro-1,1'-biphenyl						
Pentaerythritol tetranitrate/PETN						
Pentatriacontane						
Petroleum distillates						
Phenanthrene	700	700	700	1,000	2,500	2,500
Phenol	60	60	60	500	1,000	2,500
1-Phenylpropane/n-propylbenzene						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Phosphate						
α-Pinene						
Potassium						
2-Propanol						
Pyrene	500	500	500	700	2,000	5,000
Selenium	300	2,500	2,500	300	2,500	2,500
Silver	100	200	200	100	200	200
Sodium						
Steroids						
Sulfur						
Tetrachloroethylene/ tetrachloroethene	1	1	1	200	300	1,000
1,2,3,4-Tetramethylbenzene						
2,6,10,14-Tetramethylpentadecane						
Thallium	8	30	100	8	30	100
Toluene	80	80	80	500	1,000	2,500
Total organic carbon						
Total petroleum hydrocarbons	500	2,500	5,000	500	2,500	5,000
Total phosphates						
2,4,5-TP/silvex						
1,1,1-Trichloroethane	10	10	10	100	500	500
1,1,2-Trichloroethane	0.3	0.3	0.3	2	3	10

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Trichloroethylene	0.5	0.5	0.5	70	100	500
Trichlorofluoromethane						
1,3,5-Trimethylbenzene						
1,7,7-Trimethylbicyclo[2,2,1] hept-2-ene						
1,1,3-Trimethylcyclohexane						
2,4,6-Trinitrotoluene						
Vanadium						
Xylenes, total	500	800	800	500	1,000	2,500
Zinc	2,500	2,500	5,000	2,500	2,500	5,000

[a] All values are in $\mu g/g$, Code of Massachusetts Regulations Title 310, Section 40.0975(6)(a-c); Section 40.0985(6), July 30, 1993; effective October 1, 1993.
[b] Direct contact exposure- and leachate-based soil concentrations.
[c] Direct contact exposure-based soil concentrations.

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Acenaphthene	1,000	2,000	2,000	1,000	2,500	5,000
Acetone	60	60	60	500	1,000	5,000
Alcohol (high molecular weight)						
Aldehydes						
Aluminum						
4-Amino-2,6-dinitrotoluene						
Anthracene	1,000	1,000	1,000	1,000	2,500	5,000
Antimony	10	40	40	10	40	40
Arsenic	30	30	30	30	30	30
Barium						
Benzo(a)anthracene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(a)pyrene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluorene						
Benzo(ghi)perylene	30	30	30	1,000	2,500	2,500
Benzo(e)pyrine						
Benzo(k)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(j)fluoranthene						
Beryllium	0.4	0.8	3	0.4	0.8	3
ß-BHC						
Δ-BHC						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
2-Butanone						
Cadmium	30	80	80	30	80	80
Calcium						
Camphor						
Carbazole						
Carbonic acid dimethyl ether						
α-Chlordane						
µ-Chlordane						
Chlorobenzene	40	40	40	500	1,000	2,500
Chloroform	100	200	300	100	200	500
Chromium	1,000	2,500	5,000	1,000	2,500	5,000
Chrysene	0.7	0.7	0.7	0.7	0.7	0.7
Cobalt						
Copper						
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX						
Cyclotetramethylenetetranitramine/HMX						
Dacthal/DCPA						
p,p-DDD	2	3	10	2	3	10
p,p-DDE	2	2	9	2	2	9
p,p-DDT	2	2	9	2	2	9

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Dibenzofuran						
1,2-Dichloroethane	10	20	60	10	20	60
Dieldrin	0.03	0.04	0.1	0.03	0.04	0.2
Diethyl phthalate	0.7	0.7	0.7	1,000	2,500	5,000
1,3-Dimethylcyclohexane						
1,4-Dimethylcyclohexane						
1,3-Dimethylbenzene/m-xylene						
1,5-Dimethylnaphthalene						
2,4-Dinitrotoluene						
2,6-Dinitrotoluene						
Dioctyl adipate						
Endosulfan, A and sulfate						
Endosulfan, B						
Endrin	1	1	1	6	10	10
Ethylbenzene	500	500	500	500	1,000	2,500
1-Ethyl-2-methylbenzene						
Fluoranthene	600	600	600	900	2,000	5,000
Fluorene	900	400	1,000	800	2,000	5,000
Heptachlor	0.1	0.2	0.7	0.1	0.2	0.7
Heptachlor epoxide	0.06	0.09	0.3	0.06	0.09	0.3
Heptacosane						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Heptadecane						
Hexachlorobiphenyls						
Hexadecane						
Hexadecanoic acid/Palmitic acid						
Hexamethylcyclotrisiloxane						
2,2,4,4,7,7-Hexamethyloctahydro-1H-indene						
2-Hexanone						
Hexatriacontane						
Hydrocarbons (all molecular weights)						
Indeno(1,2,3-cd)pyrene						
Iron						
Isophorone						
Lead	300	600	600	300	600	600
Lindane	0.4	0.5	0.5	0.4	0.6	2
Linoleic acid						
Magnesium						
Manganese						
Mercury	10	60	60	10	60	60
Mesityl oxide						
Methylene chloride	100	200	700	100	200	700

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
4-Methyl-1-(1-methylethyl)-bicyclo[3,1,0]hex-2-ene						
2-Methylnaphthalene	7	7	7	1,000	2,500	2,500
3-Methylpentane						
Naphthalene	100	1,000	1,000	100	2,500	2,500
Nickel	300	700	700	300	700	700
Nitroglycerine						
2-Nitrotoluene						
3-Nitrotoluene						
Nonane						
Octadecanoic acid/ stearic acid						
Octane						
Oil and grease						
PCB-1242	2	2	2	2	2	2
PCB-1248	2	2	2	2	2	2
PCB-1254	2	2	2	2	2	2
PCB-1260	2	2	2	2	2	2
2,2',4,4',5-Pentachloro-1,1'-biphenyl						
2,3',4,4',5-Pentachloro-1,1'-biphenyl						
Pentaerythritol tetranitrate/PETN						
Pentatriacontane						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Petroleum distillates						
Phenanthrene	100	100	100	1,000	2,500	2,500
Phenol	500	500	500	500	1,000	2,500
1-Phenylpropane/n-propylbenzene						
Phosphate						
α-Pinene						
Potassium						
2-Propanol						
Pyrene	500	500	500	700	2,000	5,000
Selenium	300	2,500	2,500	300	2,500	2,500
Silver	100	200	200	100	200	200
Sodium						
Steroids						
Sulfur						
Tetrachloroethylene/ tetrachloroethene	200	300	1,000	200	300	1,000
1,2,3,4-Tetramethylbenzene						
2,6,10,14-Tetramethylpentadecane						
Thallium	8	30	100	8	30	100
Toluene	500	1,000	2,500	500	1,000	2,500
Total organic carbon						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Total petroleum hydrocarbons	500	2,500	5,000	500	2,500	5,000
Total phosphates						
2,4,5-TP/silvex						
1,1,1-Trichloroethane	100	500	500	100	500	500
1,1,2-Trichloroethane	2	3	10	2	3	10
Trichloroethylene	70	100	500	70	100	500
Trichlorofluoromethane						
1,3,5-Trimethylbenzene						
1,7,7-Trimethylbicyclo[2,2,1] hept-2-ene						
1,1,3-Trimethylcyclohexane						
2,4,6-Trinitrotoluene						
Vanadium						
Xylenes, total	500	1,000	2,500	500	1,000	2,500
Zinc	2,500	2,500	5,000	2,500	2,500	5,000

[a] All values are in $\mu g/g$, Code of Massachusetts Regulations Title 310, Section 40.0975(6)(a-c); Section 40.0985(6), July 30, 1993; effective October 1, 1993.
[b] Direct contact exposure- and leachate-based soil concentrations.
[c] Direct contact exposure-based soil concentrations.

cants and slope factors (SFs) for carcinogens (USEPA 1988; 53 FR 51394, December 21, 1988). RfDs and SFs are available from the EPA IRIS database (USEPA 1994) and/or the annual EPA Health Effects Assessment Summary Tables (HEAST) (USEPA 1993a). Toxicity values for all detected chemicals at the E&E sites at the Annex are provided in Table 6.

Drinking Water HAs. Table 1 provides Lifetime Health Advisories and 10^{-6} cancer risk levels (USEPA 1993b) for all detected chemicals for which values are available. The Lifetime Health Advisories for chloromethane, dacthal, RDX, and 2,4,6-trinitrotoluene are the strictest among the TBC values and would, therefore, be used as guidance for cleanup of groundwater at the Annex. The Drinking Water Equivalent Level for sodium is the strictest among the TBC values and would, therefore, be used as guidance for cleanup of groundwater at the E&E sites at the Annex. These values are calculated assuming that an individual receives 80% of his exposure from sources other than consumption of drinking water.

SDWA NIPDWR/Proposed MCLs. Pursuant to the SDWA amendments of 1986, EPA has proposed an MCL and MCLG for sulfate (400,000/500,000 μg/L). The proposed value appeared in 55 FR 30370 (July 25, 1990). EPA is deferring setting a final MCL/MCLG for sulfate pending further study (57 FR 31776, July 17, 1992). However, it should be noted that the current stricter Massachusetts SMCL of 250,000 μg/L would be the relevant and appropriate requirement at this time. National Interim Primary Drinking Water Regulations (NIPDWR) have been established for arsenic and total trihalomethanes (40 FR 59570, December 24, 1975, effective June 24, 1976). The NIPDWR for arsenic matches the MMCL (see Table 1). According to the recent EPA Regulatory Agenda, an MCL for arsenic is expected to be proposed in September 1994 (58 FR 25034, April 26, 1993), with a final rule expected in September 1996. These values are currently listed as TBC guidance in Table 1; however, when the proposed MCLs are promulgated, they will be considered applicable or relevant and appropriate for cleanup of these chemicals in groundwater at the Annex.

Massachusetts ORSGs. The MDEP Office of Research and Standards issues guidance for chemicals for which state MCLs have not been promulgated. These guidelines apply to non-chlorinated water supplies and represent a level at or below which adverse, non-cancer health effects are unlikely to occur and which generally has associated with it an excess lifetime cancer risk of less than or equal to one in one million. SDWA MCLs that have been promulgated by EPA but are not yet effective are listed as ORSGs. ORSGs are listed in Table 1 for all detected chemicals for which values are available. The ORSG for tetrahydrofuran could be used as a guidance level for remediating groundwaters contaminated with this chemical at the Annex.

Calcium, Cobalt, Magnesium, Potassium, Sulfur, Vanadium. In lieu of any available criteria for cleanup of these elements, which can be considered essential nutrients, naturally-occurring levels (background) could be considered as a guidance for establishing cleanup levels.

In lieu of any available criteria for cleanup of the remaining chemicals detected in groundwater at the Annex, the USAEC will develop cleanup criteria using a risk assessment approach and the appropriate RfDs or SFs given in Table 6.

2.2.2. Surface Water and Sediment

Lead. For assessing the risk from exposure to lead in the sediments of the surface water bodies at the Annex, EPA's Uptake/Biokinetic Model can be used, upon approval of the EPA Regional Project Manager for the Annex. The model provides a multimedia exposure approach to estimate the percentage (may vary from region to region) of the exposed population (children, ages 0-6) with blood lead levels above a critical value of 10 μg/dL.

Dieldrin, Endrin, Fluoranthene, Phenanthrene. EPA's Office of Science and Technology has proposed Sediment Quality Criteria (SQC) for the protection of benthic organisms (59 FR 2652, January 18, 1994). The criteria states that benthic organisms should be acceptably protected in freshwater sediments containing 11 μg dieldrin/g organic carbon; 4.2 μg endrin/g organic carbon; 620 μg fluoranthene/g organic carbon; and 180 μg phenanthrene/g organic carbon. These criteria will apply to sediments with $\geq$ 0.2% organic carbon. EPA sources indicate that criteria for metals are currently under development.

In lieu of any available criteria for cleanup of the chemicals detected in surface waters at the Annex for which WQC are not available and for chemicals detected in contaminated sediments for which SQC are not available, the USAEC will develop surface water and sediment cleanup criteria using a risk assessment approach and the appropriate RfDs or SFs given in Table 6. The methodology outlined in RAGS (USEPA 1989) may be utilized to quantitate exposure pathways and risk to individuals from exposure via the pathways of concern at a particular site. In addition, cleanup criteria addressing ecological risk should be developed.

2.2.3. Soil

Lead. EPA has suggested cleanup values for lead in soils based on studies of blood lead levels in exposed children. The EPA OSWER Directive 9355.4-02 (dated September 7, 1989) recommends a cleanup level for soils of 500 to 1000 ppm lead. In addition, the Uptake/Biokinetic Model as described in Section 2.2.2 above may be used to assess the risk from lead exposure for current- or future-use exposure scenarios.

In lieu of any available criteria for cleanup of the chemicals detected in soils at the E&E Sites at the Annex for which Massachusetts MCP Method 1 and/or 2 Soil Standards are unavailable, the USAEC will develop soil cleanup criteria using a risk assessment approach and the appropriate RfDs or SFs given in Table 6. The methodology outlined in RAGS (USEPA 1989) may be utilized to quantitate exposure pathways and risk to individuals from exposure via the pathways of concern at a particular site. EPA Region IV has also provided some interim guidance to be used in determining the risks associated with dermal exposure to contaminated soils: a) dermal absorption factors of 1.0% for organics and 0.1% for inorganics; b) soil to skin adherence factors ranging from 0.2 to 1.0 mg/cm^2 (these factors differ from RAGS, based on new data) (USEPA 1992). Guidance can also be obtained from EPAs Dermal Exposure Assessment: Principles and Applications (EPA/600/8-91/011B, January 1992). Again, approval of the EPA Regional Project Manager for the Annex must be obtained for using these factors in the risk calculations.

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
Acenaphthene	6.0E-02	-	-	-	-
Acenaphthylene	-	-	-	-	-
Acetone	1.0E+00	-	-	-	D
Alcohol (high molecular weight)	-	-	-	-	-
Aldehydes	-	-	-	-	-
Aluminum	-	-	-	-	-
4-Amino-2,6-dinitrotoluene	-	-	-	-	-
4-Amino-4,6-dinitrotoluene	-	-	-	-	-
Anthracene	3.0E-01	-	-	-	D
Antimony	4.0E-04	-	-	-	-
Arsenic	3.0E-04	-	5.0E-05	5.0E-01	A
Athraquinone/9,10-anthracendione	-	-	-	-	-
Barium	7.0E-02	5.0E-04	-	-	-
BBNTHF	-	-	-	-	-
7H-Benz(de)anthracen-7-one	-	-	-	-	-
Benzene	-	-	2.9E-02	2.9E-02	A
Benzo(a)anthracene	-	-	-	-	-
Benzo(a)pyrene	-	-	7.3E+00	-	B2
Benzo(b)fluoranthene	-	-	-	-	B2
Benzo(b)fluorene	-	-	-	-	-
Benzo(ghi)fluoranthene	-	-	-	-	-
Benzo(ghi)perylene	-	-	-	-	D
Benzo(e)pyrine	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	B2
Benzo(j)fluoranthene	-	-	-	-	-
Beryllium	5.0E-03	-	4.3E+00	8.4E+00	B2
α-BHC	-	-	6.3E+00	6.3E+00	B2
β-BHC	-	-	1.8E+00	1.8E+00	C
Δ-BHC	-	-	-	-	D
Bicyclohexyl	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
N,N-*Bis*(2-hydroxyethyl)dodecanamide	-	-	-	-	-
2-Butanone	-	-	-	-	-
2-(2-N-Butoxyethoxy)ethanol	-	-	-	-	-
3-(T-Butyl)phenol	-	-	-	-	-
Cadmium	5.0E-04	-	-	6.1E+00	B1
Calcium	-	-	-	-	-
Camphor	-	-	-	-	-
Carbazole	-	-	2.0E-02	-	B2
Carbon disulfide	1.0E-01	1.0E-02	-	-	-
Carbonic acid dimethyl ether	-	-	-	-	-
α-Chlordane	6.0E-05	-	1.3E+00	1.3E+00	B2
μ-Chlordane	6.0E-05	-	1.3E+00	1.3E+00	B2
Chlorobenzene	2.0E-02	2.0E-02	-	-	D
Chloroform	1.0E-02	-	6.1E-03	8.1E-02	B2
Chloromethane	-	-	1.3E-02	6.3E-03	C
Chromium (IV)	5.0E-03	4.1E+01	-	-	A
Chromium (total)	1.0E+00	-	-	-	-
Chrysene	-	-	-	-	B2
Cobalt	-	-	-	-	-
Copper	-	-	-	-	D
Cyclohexanol	-	-	-	-	-
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX	3.0E-03	-	1.1E-01	-	C
Cyclotetramethylenetetranitramine/ HMX	-	-	-	-	-
Dacthal/DCPA	5.0E-01	-	-	-	-
p,p-DDD	-	-	2.4E-01	-	B2
p,p-DDE	-	-	3.4E-01	-	B2
p,p-DDT	5.0E-04	-	3.4E-01	3.4E-01	B2
Dibenzo(a,h)anthracene	-	-	-	-	B2
Dibenzofuran	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
1,3-Dichlorobenzene	-	-	-	-	D
1,1-Dichloroethane	1.0E-01	5.0E-01	-	-	C
1,2-Dichloroethane	-	-	9.1E-02	9.1E-02	B2
Dieldrin	5.0E-05	-	1.6E+01	1.6E+01	B2
N,N-Diethyl-3-methylbenzamide	-	-	-	-	-
Diethyl phthalate	8.0E-01	-	-	-	D
Dimethyoxy dimethylsilane	-	-	-	-	-
1,3-Dimethylbenzene/m-xylene	2.0E+00	-	-	-	-
1,4-Dimethylbenzene	-	-	-	-	-
Dimethylbenzene sulfonamide	-	-	-	-	-
1,3-Dimethylcyclohexane	-	-	-	-	-
1,4-Dimethylcyclohexane	-	-	-	-	-
1,5-Dimethylnaphthalene	-	-	-	-	-
2,4-Dinitrotoluene	2.0E-03	-	6.8E-01	-	B2
2,6-Dinitrotoluene	1.0E-03	-	6.8E-01	-	B2
Dioctyl adipate	-	-	-	-	-
Dodecanoic acid/lauic acid	-	-	-	-	-
2E1HXL	-	-	-	-	-
1-Eicosanol	-	-	-	-	-
Endosulfan A	6.0E-03	-	-	-	-
Endosulfan B	-	-	-	-	-
Endosulfan sulfate	-	-	-	-	-
Endrin	3.0E-04	-	-	-	D
Endrin aldehyde	-	-	-	-	-
Ethylbenzene	1.0E-01	1.0E+00	-	-	D
Ethyl methyl benzene	-	-	-	-	-
1-Ethyl-2-methylbenzene	-	-	-	-	-
Fluoranthene	4.0E-02	-	-	-	D
Fluorene	4.0E-02	-	-	-	D
Heptachlor	5.0E-04	-	4.5E+00	4.5E+00	B2

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

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Heptachlor epoxide	1.3E-05	-	9.1E+00	9.1E+00	B2
Heptacosane	-	-	-	-	-
Heptadecane	-	-	-	-	-
Hexachlorobiphenyls	-	-	-	-	-
Hexadecane	-	-	-	-	-
Hexadecanoic acid/Palmitic acid	-	-	-	-	-
Hexamethylcyclotrisiloxane	-	-	-	-	-
2,2,4,4,7,7-Hexamethyloctahydro-1H-indene	-	-	-	-	-
2-Hexanone	-	-	-	-	-
Hexatriacontane	-	-	-	-	-
Hydrocarbons (all molecular weights)	-	-	-	-	-
4-Hydroxyl-4-methyl-2-pentanone	-	-	-	-	-
Indan/Hydrindene	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	B2
Iron	-	-	-	-	-
Isophorone	2.0E-01	-	9.5E-04	-	C
Lead	-	-	-	-	B2
Lindane	3.0E-04	-	1.3E+00	-	B2
Linoleic acid	-	-	-	-	-
Magnesium	-	-	-	-	-
Manganese	1.0E-01 [5.0E-03 (water)]	5.0E-05	-	-	D
Mercury	3.0E-04	3.0E-04	-	-	D
Mesityl oxide	-	-	-	-	-
2-(2-Methoxyethoxy)ethanol	-	-	-	-	-
2-Methoxy-1-propene	-	-	-	-	-
Methylene chloride	6.0E-02	3.0E+00	7.5E-03	-	B2
1-Methylindan	-	-	-	-	-
Methyl isobutyl ketone	8.0E-02	8.0E-02	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
4-Methyl-1-(1-methylethyl)-bicyclo[3,1,0]hex-2-ene	-	-	-	-	-
1-Methylnapthalene	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-
4-Methylphenanthrene	-	-	-	-	-
3-Methylpentane	-	-	-	-	-
4-Methylphenol	-	-	-	-	-
2-Methylpropanoic acid, 3-hydroxy-2,4,4-trimethylpentyl ester	-	-	-	-	-
7-Methyltridecane	-	-	-	-	-
Myristic acid/tetradecanoic acid	-	-	-	-	-
Naphthalene	-	-	-	-	D
Nickel	2.0E-02	-	-	-	-
Nitrate	1.6E+00	-	-	-	-
Nitrobenzene	5.0E-04	2.0E-03	-	-	D
Nitroglycerine	-	-	-	-	-
N-Nitrosodipropylamine	-	-	4.9E-03	-	B2
2-Nitrotoluene	1.0E-02	-	-	-	-
3-Nitrotoluene	1.0E-02	-	-	-	-
4-Nitrotoluene	1.0E-02	-	-	-	-
Nonadecane	-	-	-	-	-
Nonane	-	-	-	-	-
Octadecanoic acid/ stearic acid	-	-	-	-	-
Octane	-	-	-	-	-
Oil and grease	-	-	-	-	-
PAHs	-	-	-	-	-
PCB-1242	-	-	7.7E+00	-	B2
PCB-1248	-	-	7.7E+00	-	B2
PCB-1254	-	-	7.7E+00	-	B2
PCB-1260	-	-	7.7E+00	-	B2
2,2',4,4',5-Pentachloro-1,1'-biphenyl	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
2,3',4,4',5-Pentachloro-1,1'-biphenyl	-	-	-	-	-
Pentadecanoic acid	-	-	-	-	-
Pentaerythritol tetranitrate/PETN	-	-	-	-	-
Pentatriacontane	-	-	-	-	-
Petroleum distillates	-	-	-	-	-
Phenanthrene	-	-	-	-	D
Phenol	6.0E-01	-	-	-	D
Phenol-D5	-	-	-	-	-
Phenoxyacietic acid	-	-	-	-	-
2-Phenoxyethanol	-	-	-	-	-
2-(2-N-Phenoxyethoxy)ethanol	-	-	-	-	-
1-Phenylpropane/n-propylbenzene	-	-	-	-	-
Phosphate	-	-	-	-	-
α-Pinene	-	-	-	-	-
Potassium	-	-	-	-	-
2-Propanol	-	-	-	-	-
Pyrene	3.0E-02	-	-	-	D
Selenium	5.0E-03	-	-	-	D
Silver	5.0E-03	-	-	-	D
Sodium	-	-	-	-	-
Steroids	-	-	-	-	-
(3β)-Stigmast-5-en-3-ol	-	-	-	-	-
Sulfur	-	-	-	-	-
Supraene/spinacene/squalene	-	-	-	-	-
1,1,2,2-Tetrachloroethane	-	-	2.0E-01	2.0E-01	C
Tetrachloroethylene/tetrachloroethene	1.0E-02	-	-	-	B2
Tetracosane	-	-	-	-	-
1,2,3,4-Tetramethylbenzene	-	-	-	-	-
2,6,10,14-Tetramethylpentadecane	-	-	-	-	-
Thallium	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
Toluene	2.0E-01	4.0E-01	-	-	D
Total organic carbon	-	-	-	-	-
Total petroleum hydrocarbons	-	-	-	-	-
Total phosphates	-	-	-	-	-
2,4,5-TP/silvex	-	-	-	-	-
1,1,1-Trichloroethane	-	-	-	-	D
1,1,2-Trichloroethane	4.0E-03	-	5.7E-02	5.7E-02	C
Trichloroethylene	-	-	-	-	-
Trichlorofluoromethane	3.0E-01	7.0E-01	-	-	-
1,2,3-Trimethlbenzene	-	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-	-
Trimethlbenzenes	-	-	-	-	-
1,7,7-Trimethylbicyclo[2,2,1]hept-2-ene	-	-	-	-	-
1,1,3-Trimethylcyclohexane	-	-	-	-	-
2,2,4-Trimethyl-1,3-pentanediol	-	-	-	-	-
1,3,5-Trinitrobenzene	5.0E-05	-	-	-	-
2,4,6-Trinitrotoluene	5.0E-04	-	3.0E-02	-	C
Vanadium	7.0E-03	-	-	-	-
Xylenes, total	2.0E+00	-	-	-	D
Zinc	3.0E-01	-	-	-	D

[a]From IRIS (USEPA 1994) and HEAST (USEPA 1993).
[b]RfD = Chronic Reference Dose.
[c]RfC = Chronic Reference Concentration.
[d]SF = Carcinogen Slope Factor.

3. REFERENCES

Blain, P. 1994. Massachusetts Department of Environmental Protection, Division of Water Supply. Personal communication, February 23, 1994 (617-292-5948).

EEI. Ecology and Environment, Inc. 1993. Master Environmental Plan, Fort Devens Sudbury Training Annex, Massachusetts (Draft Report). Contract No. DAAA15-90-D-0012. Ecology and Environment, Inc., Arlington, VA.

Hogan, P. 1992. Environmental Engineer, Technical Services Branch, NPDES Permit Program, Massachusetts Department of Environmental Protection, Worcester, MA. Personal communication, May 5, 1992 (508-792-7470).

USEPA. U.S. Environmental Protection Agency. 1988. CERCLA Compliance with Other Laws Manual, Draft Guidance, Vol. I. OSWER Directive 9234.1001. Office of Solid Waste and Emergency Response, Washington, DC.

USEPA. U.S. Environmental Protection Agency. 1989. Risk Assessment Guidance for Superfund, Volume I. Human Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

USEPA. U.S. Environmental Protection Agency. 1992. New interim Region IV guidance. Letter received February 11, 1992. Region IV, Atlanta, GA.

USEPA. U.S. Environmental Protection Agency. 1993a. Health Effects Assessment Summary Tables. Annual, FY-1993, Supplement No. 1 (July 1993), Supplement No. 2 (November 1993). OERR 9200.6-303-(93-1). Office of Emergency and Remedial Response, Washington, DC.

USEPA. U.S. Environmental Protection Agency. 1993b. Drinking Water Regulations and Health Advisories. Office of Drinking Water, Washington, DC. (Current as of December 1993).

USEPA. U.S. Environmental Protection Agency. 1994. Integrated Risk Information System (IRIS). Office of Health and Environmental Assessment. U.S. Environmental Protection Agency. EPA/600/8-86/032a.

APPENDIX I

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

APPENDIX I

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Draft ARARs developed for the Fort Devens Sudbury Training Annex by the Oak Ridge National Laboratory were used to screen data collected during the Phase II SI conducted in 1993 by E & E at the Annex. Section 7 in Volume I of this SI report provides a discussion of how screening was performed, and presents other screening values used for the evaluation in cases where draft ARARs were not applicable. The two documents in this Appendix are:

1. Assessment of Location-Specific Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Devens Sudbury Training Annex, Massachusetts, February 21, 1994.

2. Assessment of Chemical-Specific Applicable or Relevant and Appropriate Requirements (ARARs) for Fort Devens Sudbury Training Annex, Massachusetts, February 23, 1994.

USAEC

U.S. ARMY ENVIRONMENTAL CENTER

ASSESSMENT OF LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FORT DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 21, 1994

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ASSESSMENT OF LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FT. DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 21, 1994

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ASSESSMENT OF LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FT. DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

1. INTRODUCTION

The assessment of applicable or relevant and appropriate requirements (ARARs) is an integral part of the remediation process mandated under the Comprehensive Environmental Response, Compensation and Liability Act and the Superfund Amendments and Reauthorization Act [42 U.S.C. §§ 9601-9675 (1991)]. As the preamble of CERCLA states, the purpose of the law is "to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites." In addressing hazardous substances and sites, CERCLA provides that on-site remedial actions must meet the standards and criteria that are otherwise legally applicable to the substance, pollutant, or contaminant **or** that are relevant and appropriate under the circumstances [42 U.S.C. § 9621(d)(2)(A) (1991)].

To this end, potential ARARs are identified as early as the Remedial Investigation/ Feasibility Study phase and refined throughout the process as a result of site characterization, the development, screening, and selection of remedial alternatives, and the remedial design and action. Guidance for assessing and selecting ARARs is provided in the U.S. Environmental Protection Agency's (U.S. EPA) manual "CERCLA Compliance With Other Laws" (USEPA 1988; USEPA 1989).

CERCLA remedial actions may trigger several different types of requirements or ARARs. These are organized, for convenience sake, into three categories; chemical-specific, action-specific, and location-specific. However, these categories are not always mutually exclusive and there may be some conceptual overlapping. Chemical-specific ARARs are health- or risk-based numerical values for different chemical substances (USEPA 1988). Action-specific ARARs are usually technology- or activity-based requirements or limitations (USEPA 1988). This report will specifically address the last category, the location-specific ARARS. These are restrictions or requirements for substances or activities based primarily on their specific physical location (USEPA 1988).

In order to be classified as an ARAR, a requirement must be applicable **or** relevant and appropriate. As defined in the National Contingency Plan (NCP), **applicable** requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" [40 C.F.R. § 300.5 (1991)]. **Relevant and appropriate** requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" [40 C.F.R. § 300.5 (1991)].

In either case, an applicable or a relevant and appropriate requirement for on-site remedial action must be substantive. Compliance with administrative requirements is not mandated for on-site actions (USEPA 1988). Administrative requirements are those procedures "that facilitate the implementation of the substantive requirements of a statute or regulation" (USEPA 1988). For example, CERCLA specifically exempts on-site actions from federal, state and local permitting requirements [42 U.S.C. § 9621(e)(1) (1991)]. Furthermore, only those state requirements that are more stringent than federal requirements are ARAR [40 C.F.R. § 300.5 (1991)]. "More stringent" would also necessarily include those state laws or programs that have no federal counterpart as "they add to the Federal law requirements that are specific to the environmental conditions in the State" (USEPA 1989). State requirements must be adopted by formal means (i.e. promulgated) and generally applicable (i.e. not just to Superfund sites, but to all circumstances addressed in the requirement) [42 U.S.C. § 9621(d)(2)(C)(iii)(I) (1991)].

Finally, there is a category of requirements called "To Be Considered" (TBC) guidance that may appear in this document. These are guidelines or advisories that are issued by the federal or state government, but which are neither legally binding nor promulgated (USEPA 1988). However, these guidelines may be used when they are necessary to ensure protection of public health and the environment and when they have not been superseded (USEPA 1988). If no ARARs address a particular circumstance at a CERCLA site, or if the ARARs available do not ensure protectiveness, then TBCs can be used to establish remedial guidelines or targets.

2. LOCATION-SPECIFIC ARARs

Table 1 lists the major federal and Commonwealth location-specific ARARs that might be pertinent to remedial actions at Fort Devens Sudbury Training Annex (Sudbury Annex). TBC guidance is addressed, where appropriate, in the text only.

2.1. Faults

Sudbury Annex is located near the western boundary of the Seaboard Lowland Section of the New England-Maritime Physiographic Province (EEI 1993). This area is characterized by glacial deposits underlain by a complex of metamorphic and igneous rock in tightly-folded bedrock units (EEI 1993). There are numerous faults in the area of Sudbury Annex (Foster 1994). However, they generally date to the early-Paleozoic period and there are no faults with Holocene displacement under the facility or in its vicinity (Foster 1994). The area has experienced a number of major earthquakes since the early 1700's that, while not involving fault displacement, have involved liquification of sediments (Sinnott 1992). Interestingly, earthquakes in the eastern part of the country are not associated with faults, as are those in the western United States (Oldale 1993). Rather, they are deep seated in the crust and there is, in fact, a significant earthquake potential in the northeastern United States (Oldale 1993).

Under current RCRA regulations, Sudbury Annex is exempted from compliance with the RCRA seismic requirements of 40 C.F.R. § 264.18 (1992) since § 264.18(a) stipulates that all facilities located within political jurisdictions other than those listed in Appendix VI are assumed to be in compliance for location of new treatment, storage or disposal (TSD) facilities. Massachusetts is not listed in the Appendix. EPA had intended to propose additional restrictions for location of TSD facilities; however, the rule has been put on hold because the Office of Management and Budget disagreed with the basic premise of the rule. If additional restrictions are proposed, they will be evaluated for their relevance to remedial actions at Sudbury Annex.

TABLE 1. Tentative Location-Specific Applicable or Relevant and Appropriate Requirements for FDSTA

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
Floodplains			
· Within 100-year floodplain	· Treatment, storage or disposal facility · RCRA[a]-defined listed or characteristic hazardous waste [40 C.F.R. § 261 (1992)] -or- RCRA-permitted facility	· Facility must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by 100 year flood.	· 40 C.F.R. § 264.18(b) (1992)
· Within "lowland and relatively flat areas adjoining inland and coastal waters and other floodprone areas such as offshore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year." [Executive Order 11988 § 6(c) and 40 C.F.R. § 6, Appendix A § 4(d) (1992)]	· Federal agency action which involves: - acquiring, managing, and disposing of lands and facilities - providing federally undertaken, financed, or assisted construction and improvements - conducting federal activities and programs affecting land use	· Federal agencies shall take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of floodplains. · Federal agencies shall evaluate potential effects of actions in floodplains and ensure consideration of flood hazards and floodplain management. · If action is taken in floodplains, federal agencies shall consider alternatives to avoid adverse effects, incompatible development, and minimize potential harm.	· Executive Order 11988 · 40 C.F.R. § 6.302(b) (1992) · 40 C.F.R. § 6, Appendix
· Inland and coastal land subject to flooding	· Treatment, storage or disposal facility subject to regulations under Mass. Regs. Code[b] tit. 310, § 30.800 (1989)	· Active portions of new treatment or storage facilities are prohibited within the boundary of land subject to flooding from the statistical 100-year frequency storm. · Active portions of landfills, land treatment units, surface impoundments, or waste piles are prohibited within the boundary of land subject to flooding from the statistical 500-year frequency storm.	· Mass. Regs. Code tit. 310, § 30.701(6) (1989)
· Inland and coastal land subject to flooding from the statistical 500-year frequency storm	· Landfills, land treatment unit, surface impoundment, or waste pile subject to regulation under Mass. Regs. Code tit. 310, § 30.800 (1989)	· Active portion of landfills, land treatment units, surface impoundments, or waste piles are prohibited within the boundary of land subject to flooding from the 500-year frequency storm.	· Mass. Regs. Code tit. 310, § 30.701(6) (1989)

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
· Land subject to flooding as defined in Mass. Regs. Code tit. 310, § 10.57(2) (1989)	· Activities within the area subject to flooding which involve removal, filling, dredging, or alteration of the area, as defined in Mass. Regs. Code tit. 310, § 10.04 (1989). · Activities within 100 feet of land subject to flooding which would alter the area.	· Actions in "bordering land subject to flooding" shall provide compensatory storage for flood storage volume lost as a result of the project, shall not restrict flows so as to cause an increase in flood stage or velocity, and shall not impair its capacity to provide important wildlife habitat functions or alter vernal pool habitat. · Actions in "isolated land subject to flooding" shall not result in flood damage because of lateral displacement of water that would otherwise be confined within the area, adverse effects on water supply or ground water supply, adverse effects on the capacity of the area to prevent ground water pollution, or adverse effects on vernal pool habitat.	· Mass. Gen. L.[c] ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989)
Wetlands			
· Presence of wetlands as defined in Executive Order 11990, § 7(c) and 40 C.F.R. § 6, Appendix A, § 4(j) (1992)	· Federal agency action which involves: - acquiring, managing, and disposing of lands and facilities - providing federally undertaken, finances, or assisted construction and improvements - conducting federal activities and programs affecting land use	· Whenever possible, federal agency actions must avoid or minimize adverse impacts on wetlands and act to preserve and enhance their natural and beneficial values. Agencies should particularly avoid new construction in wetlands areas unless there are no practicable alternatives. · Federal agencies shall incorporate wetlands protection considerations into planning, regulating, and decision-making processes.	· Executive Order 11990 · 40 C.F.R. § 6.302(a) (1992) · 40 C.F.R. § 6, Appendix A (1992)
· Presence of wetlands as defined in 40 C.F.R. § 230.3(t) (1992) and 33 C.F.R. § 328.3(b)*	· Action involving discharge of dredge or fill material into wetlands	· Action must be taken to avoid degradation or destruction of wetlands to the extent possible. Discharges for which there are practicable alternatives with less adverse impacts or those which would cause or contribute to significant degradation are prohibited. · If adverse impacts are unavoidable, action must be taken to enhance, restore, or create alternative wetlands.	· Clean Water Act § 404 [33 U.S.C. § 1344 (1991)] · 40 C.F.R. § 230 (1992) · 33 C.F.R. §§ 320-330*

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
· Presence of wetlands as defined in Mass. Gen. L. ch. 130, § 105 (1990) or Mass. Gen. L. ch. 131, § 40 (1990), or regulations pursuant to those statutes	· Landfills, land treatment unit, surface impoundment, or waste pile subject to regulation under Mass. Regs. Code tit. 310, § 30.800 (1989) · Hazardous waste subject to regulation under Mass. Regs. Code tit. 310, § 30.000 (1989)	· Active portions of designated facilities cannot be constructed in, or expanded into, wetlands.	· Mass. Regs. Code tit. 310, § 30.705(6) (1989)
· Presence of any bank, freshwater wetland, coastal wetland, beach, dune, flat, marsh, meadow, or swamp bordering on the ocean or on any estuary, creek, river, stream, pond, or lake **or** any land under these waters **or** land subject to tidal action, coastal storm flow, or flooding	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Removal, filling, dredging, or alteration of protected area is prohibited except under the conditions and criteria delineated in Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989).	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989)
· Presence of any bank, freshwater wetland, coastal wetland, beach, dune, flat, marsh, meadow, or swamp bordering on the ocean or on any estuary, creek, river, stream, pond, or lake **or** any land under these waters **or** land subject to tidal action, coastal storm flow, or flooding	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Removal, filling, dredging, or alteration of protected area is prohibited except under the conditions and criteria delineated in Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989). - **Applicable**	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989)
Wilderness areas, wildlife resources, wildlife refuges, or scenic rivers			
· Within area affecting stream or river -**and**- presence of fish or wildlife resources	· Action which results in the control or structural modification of a natural stream or body of water	· The effects of water-related projects on fish and wildlife resources must be considered. · Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources. · Off-site actions which alter a resource require consultation with the FWS[d], NMFS[e], and/or the appropriate state agency. · Consultation with the responsible agency is also strongly recommended for on-site actions.	· Fish and Wildlife Coordination Act (16 U.S.C. § 661*) · 40 C.F.R. § 6.302(g) (1992)
· Location encompassing aquatic ecosystem with dependent fish, wildlife, other aquatic life, or habitat	· Action involving the discharge of dredge or fill material into aquatic ecosystem	· Degradation or destruction of aquatic ecosystems must be avoided to the extent possible. Discharges which cause or contribute to significant degradation of the water of such ecosystem are prohibited.	· Clean Water Act § 404 [33 U.S.C. § 1344 (1991)] · 40 C.F.R. § 230(1992) · 33 C.F.R. §§ 320-330*

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
· Presence of areas such as wetlands, etc., as listed in Mass. Regs. Code tit. 310, § 10.02(1) 1989), which due to their plant community composition and structure, hydraulic regime, or other characteristics, provide important food, shelter, migratory or overwintering areas, or breeding areas for wildlife	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Actions which would have adverse effects on specific habitat characteristics and the important functions they serve are prohibited or regulated if they exceed certain threshold levels delineated in the regulations.	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, §§ 10..00-10.60 (1989)
<u>**Endangered, threatened or rare species**</u>			
· Presence of endangered or threatened species, or critical habitat (see above citation) of same, within an aquatic ecosystem as defined in 40 C.F.R. § 230.3(c) (1992)	· Action involving discharge of dredge or fill material into aquatic ecosystem	· Dredge or fill material shall not be discharged into an aquatic ecosystem if it would jeopardize such species or would likely result in the destruction or adverse modification of a critical habitat of the species.	· Clean Water Act § 404 [33 U.S.C.§ 1344 (1991)] · 40 C.F.R. § 230.10(b) (1992)
· Presence of endangered or threatened species **-or-** critical habitat of such species as designated in 50 C.F.R. § 17 (1989), 50 C.F.R. § 226 (1989), or 50 C.F.R. § 227 (1989)	· Action which is likely to jeopardize species or destroy or adversely modify critical habitat	· Actions which jeopardize species/habitat must be avoided or appropriate mitigation measures taken. · Off-site actions which affect species/habitat require consultation with DOI[f], FWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. · Consultation with the responsible agency is also strongly recommended for on-site actions.	· Endangered Species Act of 1973 (16 U.S.C. §§ 1531-1543*) · 50 C.F.R. § 402 (1989) · 40 C.F.R. § 6.302(h) (1992) · Fish and Wildlife Coordination Act (16 U.S.C. § 661*)
· Presence of significant habitats of state-listed species as designated pursuant to Mass. Gen. L. ch. 131A (1991)	· Action likely to alter significant habitat	· Actions which alter significant habitat are prohibited if the alteration will likely reduce the viability of a significant habitat.	· Mass. Gen. L. ch. 131A (1991) · Mass. Regs. Code tit. 321, §§ 10.00-10.61 (1992)
· Presence of a protected resources area, as designated in Mass. Regs. Code tit. 310, § 10.02(1) (1989), which is part of the habitat of a state-listed species	· Activities within a protected area which involve removal, filling, dredging, or alteration of the area · Activities within 100 feet of a protected area which would alter the area.	· Short or long term adverse effects on the habitat of the local population of the listed species are prohibited.	· Mass. Gen. L. ch. 131, § 40 (1990) · Mass. Regs. Code tit. 310, 10.00-10.60 (1989)

Location Characteristic(s)	Operating Condition(s)	Requirement(s)	Citation(s)
Archaeological and historic resources			
· Presence of archaeological or historic resources	· Action involving dam construction or other alteration of terrain which might cause irreparable loss or destruction of significant scientific, prehistoric, historic, or archaeological data	· The Secretary of the Interior must be advised of the presence of such data. · A survey must be conducted of affected areas for resources and data. Steps must be taken to recover, protect, and preserve data therefrom or DOI formally requested to do so.	· Archaeological and Historic Preservation Act [16 U.S.C. §§ 469(a)-469(c)*] · 40 C.F.R. § 6.301 (1992) · 32 C.F.R. § 650.181*
· Presence of federally owned, administered, or controlled prehistoric or historic resources -or- the likelihood of undiscovered resources		· Cultural resources included on, or eligible for inclusion on, the National Register of Historic Places (36 C.F.R. § 60*) or National Historic Landmark Program (36 C.F.R. § 65*) must be identified. · A determination must be made as to whether proposed action(s) will affect such resources and, if so, alternatives to the action(s) must be examined and considered. · When alteration or destruction of the resource is unavoidable, steps must be taken to minimize or mitigate the impacts and to preserve records and data of the resource. · When all or part of a remedial action is off-site, the consultation requirements of 16 U.S.C. § 470(f)* must be completed. · Consultation is also strongly recommended for on-site actions.	· National Historic Preservation Act [16 U.S.C. §§ 470(a)-470(w)* · Executive Order 11593 · 40 C.F.R. § 6.301 (1992) · 36 C.F.R. § 800* · 32 C.F.R. § 650.181*

[a]RCRA = Resource Conservation and Recovery Act; definitions appear at 40 CFR 260.10
[b]Mass. Regs. Code = Code of Massachusetts Regulations
[c]Mass. Gen. L. = Massachusetts General Laws
[d]FWS = U. S. Fish and Wildlife Service
[e]NMFS = National Marine Fisheries Service
[f]DOI = Department of Interior

2.2. Caves, salt-dome formations, salt-bed formations, and underground mines

Sudbury Annex is located in north central Massachusetts in Middlesex County and includes areas within the towns of Maynard, Hudson, Marlboro, Stow, and Sudbury. The installation is divided into a larger, northern section (upper section) and a smaller, southern section (lower section) by Hudson Road. The terrain is broad flat plains with scattered hills along the northern edge of the upper section, concentrating primarily in the north-central area (EEI 1993). The hilly portions consist of glacial till, with glacial outwash comprising the flat areas (EEI 1993). There are no salt formations or caves on Sudbury Annex (Foster 1994). In addition, there are no underground mines at the installation, (Foster 1994). Therefore, no ARARs developed under this location-specific category.

2.3. Floodplains and wetlands

There are abundant surface water resources on and around Sudbury Annex. The Assabet River flows adjacent to the northwestern side of the upper section (EEI 1993). Puffer Pond is located in the east central part of the upper section with Willis Pond straddling on both sides of the eastern boundary of that section. Cutting Pond and Vose Pond are located just beyond the eastern boundary, to the north of Willis Pond (EEI 1993). Crystal Lake is situated southeast of the upper section of Sudbury Annex and northeast of the lower section. White Pond and Lake Boon are just beyond installation boundaries, south/southwest of the upper section and west/northwest of the lower section. White Pond is a source of water supply for the Town of Maynard (EEI 1993). Maps of Sudbury Annex also show several small, unnamed waterbodies in the central and north-central portion of the upper section and in the eastern portion of the lower section (EEI 1993).

In addition to the open waterbodies listed above, the Assabet River flows along the northwestern border of the upper section of Sudbury Annex. There are also a number of perennial and intermittent streams on the installation (EEI 1993). Taylor Brook flows northward across the upper portion of Sudbury Annex and, along with its tributaries, drains that section of the installation into the Assabet River (EEI 1993). The western and southwestern portions of the upper section drain into White Pond and Lake Boon (EEI 1993). Marlboro Brook flows east across the lower section of the installation into Hop Brook just east of Sudbury Annex.

As might be expected, given the abundant water resources on and around Sudbury Annex, there are floodplains associated with the river (EEI 1993). It is also likely that there are floodplains associated with the streams and ponds on the installation; however, a survey or summary is not available. Additionally, the various state and federal laws addressing floodplains entail varying definitions of the resources covered under their provisions. Therefore, particular attention should be paid to the definitions and jurisdictional requirements of each statute and/or regulation.

Remedial actions that impact floodplains, depending on the particulars of the action and the location, could be subject to requirements under 40 C.F.R. § 264.18(b) (1992), Executive Order 11988, 40 C.F.R. § 6.302(b) (1992), and 40 C.F.R. § 6, Appendix A (1992). TSD facilities, landfills, land treatment units, surface impoundments, and waste piles which impact inland or coastal land subject to flooding are regulated under Mass. Regs. Code tit. 310, § 30.701(6) (1989) which would also be ARAR if the remedial action taken fall within its perview. The removal, dredge, fill, or alteration of land subject to flooding is addressed at Massachusetts General Laws (Mass. Gen. L.) ch. 131, § 40 (1990) and Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989). These

regulations would be applicable to actions that impact "bordering land subject to flooding" and "isolated land subject to flooding." The definitions, critical characteristics, and boundaries of protected areas are delineated in Mass. Regs. Code tit. 310, § 10.57(2) (1989). Assistance in addressing these Commonwealth provisions may be found in the Wetlands Protection Program Policy 85-2, "Isolated Land Subject to Flooding." Wildlife resources and rare species are also addressed under Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989). However, those provisions will be examined in more detail under sections 2.4 and 2.5 of this document.

Given that 81% of Sudbury Annex is characterized as lowlands, it is not surprising that there are numerous wetlands scattered over much of the installation (EEI 1993; Aneptek 1991). A complete description of all of these resources is beyond the scope of this text, but resource material is readily available and includes the National Wetlands Inventory Maps, the *Master Environmental Plan - Fort Devens Sudbury Training Annex, Sudbury , Massachusetts* (EEI 1993), and the *U.S. Army Natick Research, Development and Engineering Center Endagered Species Survey - Phase I: An Environmental Inventory of Wildlife Species and Their Habitats* [(See particularly Section 5 - U.S. Army Fort Devens Sudbury Annex - Taylor Drop Zone and Section 6 - Hudson (Capeheart Housing Area (lower section Sudbury Annex)] (Aneptek 1991). Briefly, the most common types of wetlands include bottomland hardwood forests along the river floodplains and the edges of water bodies, shrub swamps, which tend to be fairly stable, and freshwater emergent marshes (EEI 1993; Aneptek 1991). The latter are particularly important for waterfowl (EEI 1993).

Any remedial activities that impact wetlands may develop applicable requirements under Executive Order 11990, 40 C.F.R. § 6.302(a) (1992), 40 C.F.R. § 6, Appendix A (1992), the Clean Water Act § 404 [33 U.S.C. § 1344 (1991)], 40 C.F.R. § 230 (1992), and 33 C.F.R. §§ 320-330 (1992). Massachusetts regulations located at Mass. Regs. Code tit. 310, § 30.705(6) (1989) prohibit location of the active portion of a landfill, land treatment unit, surface impoundment, or waste pile within a wetland and Mass. Regs. Code tit. 310, § 16.40(3) (1990) prohibit the location of a solid waste landfill within a resource area protected by the Wetlands Protection Act. For the purposes of these regulations wetlands are defined according to Mass. Gen. L. ch. 130, § 105 (1990), Mass. Gen. L. ch. 131, § 40 (1990), and the regulations promulgated pursuant to those statutes. Any activities involving dredging, filling, removal, or alteration of wetlands, wet meadows, etc. would also be subject to requirements under the Wetland Protection Act, Mass. Gen. L. ch. 131, § 40 (1990), and the Wetlands Protection Regulations at Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989).

While these latter Commonwealth requirements regulate the same activities as the federal requirements in and pursuant to the Clean Water Act, they are "stricter" in that they address protection to a wider variety of resources, including wetlands, banks, dunes, etc. [see Mass. Regs. Code tit. 310, § 10.02(1) (1989)]. In addition, the regulations restrict activities within 100 feet of the wetland or other resource, in the "Buffer Zone," and provide protection for wildlife resources and rare species. These regulations are very comprehensive and a complete analysis of their provisions is beyond the scope of this document. They should be carefully reviewed and to the extent that the coverage of the regulations are broader than the federal counterpart, they would be applicable for actions subject to the regulations that impact protected resources. Assistance in addressing these regulations may be found in Wetlands Protection Program Policy 85-1, "Interpretation of Identified Vegetation," and Wetlands Protection Program Interim Guidance 90-TG1, "Aquatic Plant Control."

2.4. Wilderness areas, wildlife refuges, wildlife resources, scenic rivers

There are no scenic rivers, wildlife refuges or wilderness areas on Sudbury Annex, or within impact range of the installation. However, Sudbury State Forest is located just outside the southern edge of the upper section of the installation, between that portion and the lower section (EEI 1993; Aneptek 1991). If any remedial activities appear likely to impact this resource, the appropriate state official and/or management personnel should be contacted for guidance as to any requirements.

Given the natural resources and habitats on Sudbury Annex, the presence of wildlife resources is predictable. Sources for more detailed descriptions include the *Master Environmental Plan - Fort Devens Sudbury Training Annex, Massachusetts* (EEI 1993) and the *U.S. Army Natick Research, Development and Engineering Center Endagered Species Survey - Phase I: An Environmental Inventory of Wildlife Species and Their Habitats* [(See particularly Section 5 - U.S. Army Fort Devens Sudbury Annex - Taylor Drop Zone and Section 6 - Hudson (Capeheart Housing Area (lower section Sudbury Annex)] (Aneptek 1991). Particular note should be taken of the presence of, and the potential for, vernal pool habitats on Sudbury Annex (EEI 1993; Aneptek 1991).

Any remedial activity that results in the control of a natural stream or water body with fish or wildlife resources may be subject to applicable requirements under the Fish and Wildlife Coordination Act (16 U.S.C. § 661 (1992)) and 40 C.F.R. § 6.302(g) (1992). Any action involving the discharge of dredge or fill material into an aquatic ecosystem with dependant fish, wildlife, other aquatic life, or habitat would dictate consideration of the Clean Water Act § 404 [33 U.S.C. § 1344 (1991), 40 C.F.R. § 230 (1992), and 33 C.F.R. §§ 320-330 (1992). Remedial activities involving removal, alteration, dredging or filling, of wetlands, lands subject to flooding, and various other areas would also implicate applicable requirements under Mass. Gen. L. ch. 131, § 40 (1990) and Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989), which provide protection for certain wildlife habitats that provide important food, shelter, migratory or overwintering areas, or breeding areas for wildlife. Vernal pool habitats receive special consideration under these regulations and there are certain thresholds established for impacts in other areas. The Massachusetts regulations are very comprehensive and should be reviewed in detail if protected resources are identified in any location where remedial activities will occur. Assistance in this process may be found in Wetlands Protection Program Policy 88-1, "Inland Wildlife Habitats," Wetlands Protection Program Policy 88-5, "Wetlands Wildlife Advisory," and Wetlands Protection Program Interim Guidance 90-TG1, "Aquatic Plant Control."

2.5. Rare, threatened, or endangered species

Recent studies and observations at Sudbury Annex have identified a number of rare, threatened, or endangered species at the installation (EEI 1993; Aneptek 1991). A list of rare, threatened, and endangered species is provided in Table 2-5 of the *Master Environmental Plan - Fort Devens Sudbury Training Annex* (EEI 1993). There is some controversy regarding the grass-leaved Ladies' Tress (*Spiranthes Vernalis*), a state species of special concern. This species was documented by Aneptek during an endangered species survey that included portions of Sudbury Annex, specifically the Taylor Drop Zone and the Hudson (Capeheart) Housing Area (lower portion) (Aneptek 1991). Apparently, the presence of the plant was disputed by a later survey (EEI 1993).

If any rare, threatened, or endangered species are impacted by remedial activities at Sudbury Annex, applicable requirements may develop under the Endangered Species Act of 1973 (16 U.S.C. §§ 1531-1543 (1992), 50 C.F.R. § 17 (1989), 50 C.F.R. § 402 (1989), 40 C.F.R. § 6.302(h) (1992), and the Fish and Wildlife Coordination Act (16 U.S.C. § 661 (1992)). Moreover, any activity involving the discharge of dredge or fill material into an aquatic ecosystem would invoke the provisions of the Clean Water Act § 404 [33 U.S.C. § 1344 (1991) and 40 C.F.R. § 230.10(b) (1992) as applicable requirements. Mass. Regs. Code tit. 310, § 16.40 (4)(c) (1990) prohibit the location of a solid waste landfill in an area that would have an adverse impact on an endangered, threatened, or special concern species or on an ecologically significant natural community listed by the Natural Heritage and Endangered Species Program. The Massachusetts Wetlands Protection Act (Mass. Gen. L. ch. 131, § 40 (1990) and its regulations (Mass. Regs. Code tit. 310, §§ 10.00-10.60 (1989) provide requirements that would apply if a remedial activity alters a protected resources area [see Mass. Regs. Code tit. 310, § 10.02 (1989)] that is part of the estimated habitat of a rare species. "Estimated Habitat Maps" for rare state-listed species are available from the Massachusetts Natural Heritage and Endangered Species Program. Assistance in addressing these Commonwealth regulations may be found in Wetlands Protection Program Policy 90-2, "Rare Species Habitat." Furthermore, if any habitat of a state-listed species on FTD is designated by Massachusetts as "significant habitat," the substantive requirements of the Massachusetts Endangered Species Act [Mass. Gen. L. ch. 131A (1991)], and its attendant regulations located at Mass. Regs. Code tit. 321, §§ 10.00-10.61 (1992), would be applicable.

2.6. Archaeological resources and historic sites

Prior to the development of Sudbury Annex and the surrounding towns, the principle land use in the area was agriculture (EEI 1993; Aneptek 1991). In 1984 a survey of cultural resources over approximately 20% of the installation was completed pursuant to the installation's responsibilities for these resources under federal legislation (EEI 1993). The survey identified twenty-eight (28) historic sites, two of which, the remains of Rice or Vose Tavern and the Puffer family homestead, were deemed potentially significant (EEI 1993). The survey also identified twenty-five prehistoric sites (EEI 1993). Three of these are apparently considered potentially significant, but further information regarding their descriptions and locations, etc. is not available at this time (EEI 1993). In addition, the Taylor Testing Area (Taylor Drop Zone) is the only facility in the United States that performs certain specific testing procedures involving materials dropped from remote control, drone airplanes (Aneptek 1991).

If any archaeological or historic resources are impacted by remedial activities, applicable requirements would develop under the Archaeological Resources Recovery Act of 1979 [16 U.S.C. §§ 470(aa)-470(ll) (1992)], 43 C.F.R. § 7 (1992), 32 C.F.R. § 229 (1992), the Archaeological and Historic Preservation Act [16 U.S.C. §§ 469(a)-469(c) (1992)], 40 C.F.R. § 6.301 (1992), and 32 C.F.R. § 650.181 (1992). In addition, any property that is eligible for the National Register of Historic Places or the National Historic Landmark Program, would be subject to applicable requirements under the National Historic Preservation Act [16 U.S.C. §§ 470(a)-470(w) (1992)], Executive Order 11593, 40 C.F.R. § 6.301 (1992), 36 C.F.R. § 800 (1992), and 32 C.F.R. § 650.181 (1992).

Massachusetts addresses the protection of historical and archaeological resources in the Antiquities Act located at Mass. Gen. L. ch. 9, § 26 (1992). The statute specifically authorizes the administration of the National Historic Preservation Act [16 U.S.C. §§ 470(a)-470(w) (1992)] within the Commonwealth at Mass. Gen. L. ch. 9, § 27B (1992). The state register of historic places includes, among others, all properties listed on or eligible for the National Register of

Historic Places. Under regulations located at Mass. Regs. Code tit. 950, §§ 71.01-71.12 (1989) the Massachusetts Historical Commission (MHC) reviews any projects affecting the resources on the state list to determine if there will be adverse impacts on the resources and, if so, how to eliminate or mitigate those impacts. However, the MHC does not have veto power over projects as such and the regulations are not strictly "applicable" to CERCLA cleanup sites. However, relevant and appropriate requirements for remedial actions that impact state-listed resources can be found at Mass. Regs. Code tit. 950, § 71.05 (1989), which is promulgated pursuant to Mass. Gen. L. ch. 9, §§ 26-27C (1992).

Although not required, the process of consultation with the MHC to eliminate or mitigate adverse impacts may be recommended if any remedial alternatives at Sudbury Annex impact historical or archaeological resources. This is particularly true in light of the federal mandate to protect and preserve historical and archaeological resources and data and the fact that the federal review can be accomplished in conjunction with review by the MHC. Indeed, Mass. Regs. Code tit. 950, § 71.04(2) (1989) contemplates such coordination by providing that the review required under section 106 of the National Historic Preservation Act be undertaken, pursuant to Mass. Gen. L. ch. 9, § 27B (1992), by submission of the notification to the MHC.

2.7. Miscellaneous requirements

The Commonwealth regulations addressing TSD facility and solid waste landfill siting requirements have been discussed in Sections 2.3, 2.4, and 2.5 concerning impacts to floodplains, wetlands, wildlife resources, and endangered, threatened, or rare species. In addition, it is important to note that these regulations, located at Mass. Regs. Code tit. 310, §§ 30.700-30.707 (1989) and Mass. Regs. Code tit. 310, § 16.40(3) - (4) (1990), also address location requirements that involve resources not previously included in this document. These regulations require that the location of any new facility be evaluated with regard to transportation risks associated with the waste(s), adequacy of the buffer zone between active portions of the facility and areas of public access, population density in the vicinity of the site, proximity to "sensitive receptors" (eg. schools, hospitals, day care centers, residential dwellings, etc.), and proposed methods of evacuation of any populations that might be threatened in the event of any accident. In addition, buffer zones are required between the active portions of various facilities and their facility property lines and active farmland. These regulations may be relevant and appropriate requirements should the items or resources, etc. subject to the regulation be impacted by remedial actions. Given the location of Sudbury Annex within several towns and communities, particular attention should be paid to these requirements and their potential applicability.

REFERENCES

Aneptek. Aneptek Corporation. 1991. Endangered Species Survey - Phase I An Environmental Inventory of Wildlife Species and Their Habitats, Final Report. Contract No. DAAK6091P2517. Aneptek Corporation, Natick, MA.

EEI. Ecology and Environment, Inc. 1993. Master Environmental Plan - Fort Devens Sudbury Training Annex, Massachusetts. Contract No. DAAA15-90-D-0012. Ecology and Environment, Inc., Arlington, VA.

Foster, D. 1994. State Geologist, Executive Office of Environmental Affairs, Boston, MA. Personal communication, February 7, 1994 (617-727-9800).

Oldale, R. 1993. Geologist, Geologic Division, Woods Hole, MA. Personal communication, June 4, 1993.

Sinnott, J. 1992. State Geologist, Executive Office of Environmental Affairs, Boston, MA. Personal communication, April 16, 1992 (617-727-9800, ext. 213).

USEPA. United States Environmental Protection Agency. 1988. CERCLA Compliance With Other Laws, Draft Guidance. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

USEPA. United State Environmental Protection Agency. 1989. CERLCA Compliance With Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

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U.S. ARMY ENVIRONMENTAL CENTER

ASSESSMENT OF CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FORT DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 23, 1994

CHEMICAL HAZARD EVALUATION GROUP
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ASSESSMENT OF CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR FT. DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

REGULATORY DRAFT

February 23, 1994

Chemical Hazard Evaluation Group
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ASSESSMENT OF CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) FOR THE FORT DEVENS SUDBURY TRAINING ANNEX, MASSACHUSETTS

1. INTRODUCTION

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) was passed by Congress and signed into law on December 11, 1980 (Public Law 96-510). This act was intended to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites." The Superfund Amendments and Reauthorization Act (SARA), adopted on October 17, 1986 (Public Law 99-499), did not substantially alter the original structure of CERCLA but provided extensive amendments to it.

In particular, Title I, § 121 of SARA specifies that for any hazardous substance, pollutant, or contaminant that remains on-site, the level or standard of control that must be met shall be at least that of any legally applicable or relevant and appropriate regulation (ARAR), standard, criteria, or limitation under any federal environmental law or any more stringent standard promulgated under state environmental or facility siting law. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

The U.S. Army Environmental Center (USAEC) has asked the support of the Chemical Hazard Evaluation Group in the Health and Safety Research Division at Oak Ridge National Laboratory (ORNL) for assistance in determining chemical-specific ARARs for the Fort Devens Sudbury Training Annex (the Annex), Middlesex County, Massachusetts. The Annex was proposed for listing on the National Priorities List (NPL) in 1989 (54 FR 29820, July 14, 1989) and finalized in 1990 (55 FR 6154, February 21, 1990). The support document used in the preparation of this document is the Draft Master Environmental Plan (EEI 1993).

The following is a listing of the definitions of terms used throughout this report:

Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" [40 CFR § 300.5 (1991)].

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" [40 CFR § 300.5 (1991)].

Requirements under federal or state law may be *either* applicable *or* relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be *both* relevant *and* appropriate for compliance to be necessary. In the case where a federal and a state ARAR are available, or where there are two potential ARARs addressing the same issue, the more stringent regulation must be selected. However, CERCLA §121(d)(4) provides several ARAR waiver options that may be invoked, providing that the basic premise of protection of human health and the environment is not ignored. A waiver is available for state standards that have not been applied uniformly in similar circumstances across the state.

CERCLA on-site remedial response actions must only comply with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA §121(e) and FFA §XXII]. To ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final NCP (55 Fed. Reg. 8756, March 8, 1990). **Substantive requirements** pertain directly to the actions or conditions at a site, while **administrative requirements** facilitate their implementation. EPA recognizes that certain of the administrative requirements such as consultation with state agencies, reporting, etc., are accomplished through the state involvement and public participation requirements of the NCP. These administrative requirements should be observed if they are useful in determining cleanup standards at the site.

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs but are **"to-be-considered" (TBC)** guidance [40 CFR 300.400(g)(3)(1991)].

Selection of ARARs is dependent on the hazardous substances present at the site, the site characteristics and location, and the actions selected for a remedy. Thus, these requirements may be chemical-, location-, or action-specific. Chemical-specific ARARs are health- or risk-based concentration limits set for specific hazardous substances, pollutants, or contaminants. Location-specific ARARs address such circumstances as the presence of an endangered species on the site or the location of the site in a 100-year floodplain. Location-specific ARARs are being provided under separate cover. Action-specific ARARs control or restrict particular types of remedial actions selected as alternatives for cleanup of the site. Action-specific ARARs will be determined when remedial alternatives are selected during the Feasibility Study.

The Annex encompasses 2,750 acres and is located in Middlesex County, Massachusetts, 20 miles west of Boston. Portions of the towns of Maynard, Hudson, Marlboro, Stow, and Sudbury are within the boundaries of the installation. The Annex has served several uses including ammunition storage; ordnance research and development; laboratory research; equipment field testing; railroad operations; troop training; and disposal of cloth, food, and chemicals. Potential contaminants are explosives; solvents; pesticides and herbicides; polychlorinated biphenyls (PCBs); heavy metals; and petroleum fuels, oils and lubricants (EEI 1993). Past site assessments and remedial investigations identified 68 sites as potential areas of contamination. Feasibility studies are currently being conducted by OHM Corporation on three of the sites (A4, A7/P8, A9/P12). Twenty-eight of the sites are being

proposed for no further action. Site investigations/remedial investigations (SI/RI) are being conducted by Ecology and Environment, Inc. (E&E) on two of the sites (P11 and P37) and SIs are being conducted for 36 sites. This report will provide chemical-specific ARARs for all chemicals detected at the E&E sites. The sites have been grouped according to watersheds: Watershed 1A - Taylor Brook above Honey Brook; Watershed 1B - Taylor Brook below Honey Brook; Watershed 2 - Hop Brook Drainage; Watershed 3 - Unnamed tributary 1 to Assabet River (North End); Watershed 4 - unnamed tributary 2 to Assabet River (Northwest End); Watershed 5 - Boons Pond Drainage; and Watershed 6 - Run Brook (Willis Pond) Drainage.

The Annex is located near the western boundary of the Seaboard Lowland Section of the New England-Maritime physiographic province. The installation is located within the Eastern White Pine and Scarlet Oak forest cover types. Lowland areas, including bogs, marshes, and swamps, occur throughout the installation. The depth to the water table is less than 15 feet, with groundwater occurring mostly in the outwash plain underlying the lowlands. Groundwater flow in the glacial aquifers is controlled by surface geology and discharge to surface water bodies. Groundwater yields in the impermeable till or bedrock is low. On-site surface waters flow into the Assabet River, which is in the Concord River Basin. Most of the northern section of the Annex drains northward towards Taylor Brook and its associated tributaries, which eventually drain into the Assabet River. Honey Brook, which drains into Taylor Brook, originates in the western section of the installation. The southwestern and western sections of the Annex drain into either White Pond or Lake Boon, which discharge to the Assabet River. White Pond, which is used as a source of water supply for the town of Maynard, drains underground into Lake Boon. The remainder of the Annex drains into Hop Brook or it tributaries (Run Brook and Marlboro Brook). Hop Brook discharges to the Sudbury River prior to its confluence with the Assabet River (EEI 1993).

2. CHEMICAL-SPECIFIC ARARs

This report provides available chemical-specific ARARs or "to be considered" (TBC) guidance values to set protective cleanup levels for all chemicals detected in the designated media at the E&E sites or else indicate a safe level of discharge that may be incorporated when considering a specific remedial activity.

2.1. Federal and State ARARs

2.1.1. Drinking Water and Groundwater

In the final National Contingency Plan (NCP), EPA states a preference for Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and non-zero maximum contaminant level goals (MCLGs) or other health-based standards, criteria, or guidance for cleanup of Class I and II groundwater at CERCLA sites (55 FR 8732). The goal of EPA's approach to clean up contaminated groundwater is to return usable groundwater to its beneficial use within a given time frame that is reasonable given the particular circumstances at a CERCLA site. Although not an ARAR unless promulgated, the EPA guidance on

groundwater classification should be used to help in determining whether groundwater at a site falls within Class I, II or III. Classes I and IIA represent current sources of drinking water of varying value; Class IIB represents potential sources of drinking water; and Class III groundwater is not considered to be a potential source of drinking water and is of limited beneficial use. Restoration time periods vary depending on the use classification of the groundwater and may range from one year to several decades. Aquifers in certain areas of the Annex are used for drinking water supplies and certain areas of groundwater are classified by the Massachusetts Division of Water Supply as Zone II, which is a defined area of groundwater that contributes water to pumped wells with an approved capacity of >100,000 gallons/day (Blain 1994). Three public water supply wells in the Sudbury Water District (Wells #3, 8, and 10) are located within the Annex boundaries just north of Willis Pond. A public water supply well for the Maynard Public Works Department - Water Division (Well #3) is located within the Annex boundaries north of Puffer Pond. White Pond, located just south of the Annex boundary, serves as a public water supply for the town of Hudson. In addition, the Massachusetts Bureau of Waste Site Cleanup's Priority Resource Map for this area indicates areas of medium to high yield aquifers, particularly on the western side of the installation (Blain 1994). Consequently, certain areas of groundwater underlying the Annex would be classified by EPA's approach as Class I and IIA and certain areas of groundwater could be considered potential sources of drinking water or Class IIB. There is also the potential that other areas of groundwater may be unsuitable for water supply but may discharge to surface water bodies.

Although limited in number, chemical-specific standards pertaining to water quality have been established under the SDWA in 40 CFR 141 as National Primary Drinking Water Standards (NPDWS). These regulations are applicable to public water systems that have at least 15 service connections or serve an average of at least 25 people daily at least 60 days of the year. NPDWS include MCLs and MCLGs. The MCLs are enforceable standards that take into consideration human health effects, available treatment technologies, and costs of treatment. MCLs would be legally applicable to remediation of any Zone II groundwater or of groundwater that serves a public water supply well at the Annex. These MCLs would also be relevant and appropriate requirements for remediation of medium to high yield areas of groundwater that could be a potential source of drinking water supply. MCLGs are strictly health-based standards that disregard cost or treatment feasibility and are not legally enforceable, but would be relevant and appropriate for cleanup of groundwater at the Annex. Table 1 lists SDWA MCLs and MCLGs for the detected chemicals in groundwater at the Annex. Pursuant to the SDWA amendments of 1986, EPA has promulgated MCLs for fluoride (51 FR 11396, April 2, 1986, effective October 2, 1987); for benzene, 1,1-dichloroethylene, 1,1,1-trichloroethane, and trichloroethylene (52 FR 25690, July 8, 1987, effective January 9, 1989); for cadmium, chlordane, chlorobenzene, chromium, ethylbenzene, heptachlor, heptachlor epoxide, lindane, mercury, nitrate, polychlorinated biphenyls, selenium, tetrachloroethylene, toluene, and xylene (56 FR 3526, January 30, 1991, effective July 30, 1992); for barium (56 FR 30266, July 1, 1991, effective January 1, 1993); and for antimony, beryllium, endrin, methylene chloride, nickel, (57 FR 31776, July 17,1992, effective August 17, 1992).

The Commonwealth of Massachusetts has adopted Drinking Water Standards and Guidelines, expressed in terms of maximum levels of contaminants allowable in drinking

Table 1. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Groundwater Used as Drinking Water Supply at the E&E Sites at Sudbury Training Annex[a]

Chemical	Applicable			Relevant and Appropriate			TBC Guidance[b]			
	SDWA[c] MCL[d]	MMCL[e]	MA Groundwater Standard[f]	SDWA MCLGs[g]	MA SMCLs[h]	SDWA Action Level[i]	SDWA SMCL[j]	Drinking Water HA[k]	SDWA NIPDWR/ Proposed MCL[l]	MA ORSG[m]
Acetone			3,000							3,000
Alcohols (high molecular weight)										
Aluminum					50/200		50/200			
2-Amino-4,6-dinitrotoluene										
4-Amino-2,6-dinitrotoluene										
Antimony	6		6	6				3		6
Arsenic		50	50					0.02[n]	50	
Barium	2,000	2,000		2,000				2,000		
Benzene	5	5	5	0				1[n]		
Beryllium	4		4	0				0.008[n]		4
α-BHC										
Bicyclohexyl										
2-Butanone										
Cadmium	5	5	5	5				5		
Calcium										
Carbon disulfide										
α-Chlordane	2	5	5	0				0.03[n]		
Chlorobenzene	100	100	100					100		
Chlorodifluoromethane										
Chloroform		100[o]	5					6[n]	100[o]	5

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	SDWA[c] MCL[d]	MMCL[e]	MA Groundwater Standard[f]	SDWA MCLGs[g]	MA SMCLs[h]	SDWA Action Level[i]	SDWA SMCL[j]	Drinking Water HA[k]	SDWA NIPDWR/ Proposed MCL[l]	MA ORSG[m]
Chloromethane								3		
Chromium (IV)			50							
Chromium (Total)	100	100	100	100				100		
Cobalt										
Copper		1,300		1,300	1,000	1,300	1,000			
Cyclohexanol										
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX								2		
Dacthal/DCPA								4,000		
p,p-DDD			0.1							
p,p-DDT			0.3							
1,3-Dichlorobenzene			600					600		
1,1-Dichloroethylene	7	7	7	7				7		
Dieldrin			0.1					0.002[n]		
N,N-Diethyl-3-methylbenzamide										
Dimethoxy dimethylsilane										
1,3-Dimethylbenzene/m-xylene										
1,4-Dimethylbenzene										
2,4-Dinitrotoluene			30							
Dioctyl adipate										
Endosulfan, B			0.4							

Table 1. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Groundwater Used as Drinking Water Supply at the E&E Sites at Sudbury Training Annex[a]

Chemical	Applicable			Relevant and Appropriate			TBC Guidance[b]			
	SDWA[c] MCL[d]	MMCL[e]	MA Groundwater Standard[f]	SDWA MCLGs[g]	MA SMCLs[h]	SDWA Action Level[i]	SDWA SMCL[j]	Drinking Water HA[k]	SDWA NIPDWR/ Proposed MCL[l]	MA ORSG[m]
Endrin	<u>2</u>	2	2	2				2		
Endrin aldehyde										
Ethylbenzene	<u>700</u>	700	700	700				700		
Ethyl methyl benzene										
1-Ethyl-2-methylbenzene										
Heptachlor	<u>0.4</u>	0.4	0.4	0				0.008[n]		
Heptachor epoxide	<u>0.2</u>	0.2	0.2	0				0.004[n]		
Hexamethylcyclotrisiloxane										
2-Hexanone										
Hydrocarbons (all molecular weights)										
4-Hydroxyl-4-methyl-2-pentanone										
Indan/Hydrindene										
Iron					<u>300</u>		300			
Lead		<u>15</u>	15	0		15				
Lindane	<u>0.2</u>	0.2	0.2	0.2				0.2		
Magnesium										
Manganese					<u>50</u>					
Mercury	<u>2</u>	2	2	2				2		
2-Methoxy-1-propene										
Methylene chloride	<u>5</u>		5	0						

Table 1. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Groundwater Used as Drinking Water Supply at the E&E Sites at Sudbury Training Annex[a]

Chemical	Applicable			Relevant and Appropriate			TBC Guidance[b]			
	SDWA[c] MCL[d]	MMCL[e]	MA Groundwater Standard[f]	SDWA MCLGs[g]	MA SMCLs[h]	SDWA Action Level[i]	SDWA SMCL[j]	Drinking Water HA[k]	SDWA NIPDWR/ Proposed MCL[l]	MA ORSG[m]
1-Methylindan										
Methylisobutyl ketone			350							350
1-Methylnaphthalene										
2-Methylnaphthalene			10							
Naphthalene			20					20		
Nickel	100		100	100				100		100
Nitrate	10,000	10,000		10,000						
Nitrobenzene										
Nitroglycerine										
2-Nitrotoluene										
3-Nitrotoluene										
4-Nitrotoluene										
Oil and grease										
PCB-1254	0.5	0.5	0.5	0				0.005[n]		
Pentaerythritol tetranitrate/PETN										
Phosphate										
Potassium										
Selenium	50	50	50	50						
Silver			40		100		100	100		
Sodium								20,000[k]		28,000

Table 1. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Groundwater Used as Drinking Water Supply at the E&E Sites at Sudbury Training Annex[a]

Chemical	Applicable			Relevant and Appropriate			TBC Guidance[b]			
	SDWA[c] MCL[d]	MMCL[e]	MA Groundwater Standard[f]	SDWA MCLGs[g]	MA SMCLs[h]	SDWA Action Level[i]	SDWA SMCL[j]	Drinking Water HA[k]	SDWA NIPDWR/ Proposed MCL[l]	MA ORSG[m]
Sulfate					250,000		250,000		400,000/ 500,000	
Sulfur										
Supraene/spinacene/squalene										
Tetrachloroethylene/ tetrachloroethene	5	5	5	0				0.7[n]		
Tetrahydrofuran										1,300
1,2,3,4-Tetramethylbenzene										
Toluene	1,000	1,000	1,000	1,000				1,000		
Total petroleum hydrocarbons			1,000							
1,1,1-Trichloroethane	200	200	200	200				200		
Trichloroethylene/Trichloroethene	5[q]	5	5	0				3[n]		
1,2,3-Trimethylbenzene										
Trimethylbenzenes										
1,3,5-Trinitrobenzene										
2,4,6-Trinitrotoluene								2		
Vanadium										
Xylene	10,000	10,000	10,000	10,000				10,000		
Zinc			2,000		5,000		5,000	2,000		

[a] This table provides ARARs or TBC guidance for all chemical historically detected in groundwater at Sudbury Training Annex (based on monitoring data from USAEC Installation Restoration Database Management Information System, as of December 21, 1993). The underlined values indicate the ARAR or TBC for each chemical. The

applicable requirements (SDWA MCLs and MMCLs) would also be relevant and appropriate requirements for remediation of the medium to high yield areas of groundwater underlying the Annex.

[b] TBC = "To be considered" guidance.

[c] SDWA = Safe Drinking Water Act.

[d] MCL = Maximum Contaminant Level. 52 FR 25690 (July 8, 1987); 56 FR 3526 (January 30, 1991); 56 FR 30266 (July 1, 1991); 57 FR 31776 (July 17, 1992).

[e] Code of Massachusetts Regulations, Title 310, Section 22, Drinking Water Regulations, effective November 20, 1992.

[f] Code of Massachusetts Regulations, Title 310, Section 40.0974(2), Groundwater Standards for category GW-1 July 30, 1993, effective October 1, 1993.

[g] MCLG = Maximum Contaminant Level Goal.

[h] SMCL = Secondary Maximum Contaminant Level, Code of Massachusetts Regulations, Title 310, Section 22, effective November 20, 1992.

[i] Established as an action level/MCLG, 56 FR 26460 (June 7, 1991), effective December 7, 1992.

[j] National Secondary Drinking Water Standards designed to protect the aesthetic quality of water (44 FR 42198, July 19, 1979; 51 FR 11396, April 2, 1986; 56 FR 3526, January 30, 1991).

[k] USEPA Office of Water Lifetime Health Advisories (HA), May 1993. The value for sodium is a Drinking Water Equivalent Level guidance value.

[l] NIPDWR = National Interim Primary Drinking Water Regulation. NIPDWR for arsenic - 40 FR 59570 (December 24, 1975), Notice of Proposed Rulemaking expected September 1994, Final rule expected September 1996. Proposed MCL for sulfates - 55 FR 303070, September 25, 1990, EPA has deferred setting final standard pending further study (57 FR 31776, July 17, 1992).

[m] ORSG = Office of Research and Standard Guidelines, Massachusetts Department of Environmental Protection, Spring 1993. The ORSG for chloroform is for non-chlorinated water supplies.

[n] USEPA Office of Water Health Advisory representing a 10^{-6} cancer risk, the concentration in drinking water that will result in one excess cancer death in one million people.

[o] These values are for Total Trihalomethanes, which is the sum of the concentration of chloroform, bromodichloromethane, dibromochloromethane, and bromoform. NIPDWR 40 FR 59570 (December 24, 1975), effective June 24, 1976.groundwater classification should be used to help in determining whether groundwater at a site falls within Class I, II or III. Classes I and IIA represent current sources of drinking water of varying value; Class IIB represents potential sources of drinking water; and Class III groundwater is not considered to be a potential source of drinking water and is of limited beneficial use. Restoration time periods vary depending on the use classification of the groundwater and may range from one year to several decades. Aquifers in certain areas of the Annex are used for drinking water supplies and certain areas of groundwater are classified by the Massachusetts Division of Water Supply as Zone II, which is a defined area of groundwater that contributes water to pumped wells with an approved capacity of >100,000 gallons/day (Blain 1994). Three public water supply wells in the Sudbury Water District (Wells #3, 8, and 10) are located within the Annex boundaries just north of Willis Pond. A public water supply well for the Maynard Public Works Department - Water Division (Well #3) is located within the Annex boundaries north of Puffer Pond. White Pond, located just south of the Annex boundary, serves as a public water supply for the town of Hudson. In addition, the Massachusetts Bureau of Waste Site Cleanup's Priority Resource Map for this area indicates areas of medium to high yield aquifers, particularly on the western side of the installation (Blain 1994). Consequently, certain areas of groundwater underlying the Annex would be classified by EPA's approach as Class I and IIA and certain areas of groundwater could be considered potential sources of drinking water or Class IIB. There is also the potential that other areas of groundwater may be unsuitable for water supply but may discharge to surface water bodies.

Although limited in number, chemical-specific standards pertaining to water quality have been established under the SDWA in 40 CFR 141 as National Primary Drinking Water Standards (NPDWS). These regulations are applicable to public water systems that have at least 15 service connections or serve an average of at least 25 people daily at least 60 days of the year. NPDWS include MCLs and MCLGs. The MCLs are enforceable standards that take into consideration human health effects, available treatment technologies, and costs of treatment. MCLs would be legally applicable to remediation of any Zone II groundwater or of groundwater that serves a public water supply well at the Annex. These MCLs would also be relevant and appropriate requirements for remediation of medium to high yield areas of groundwater that could be a potential source of drinking water supply. MCLGs are strictly health-based standards that disregard cost or treatment feasibility and are not legally enforceable, but would be relevant and appropriate for cleanup of groundwater at the Annex. Table 1 lists SDWA MCLs and MCLGs for the detected chemicals in groundwater at the Annex. Pursuant to the SDWA amendments of 1986, EPA has promulgated MCLs for fluoride (51 FR 11396, April 2, 1986, effective October 2, 1987); for benzene, 1,1-dichloroethylene, 1,1,1-trichloroethane, and trichloroethylene (52 FR 25690, July 8, 1987, effective January 9, 1989); for cadmium, chlordane, chlorobenzene, chromium, ethylbenzene, heptachlor, heptachlor epoxide, lindane, mercury, nitrate, polychlorinated biphenyls, selenium, tetrachloroethylene, toluene, and xylene (56 FR 3526, January 30, 1991, effective July 30, 1992); for barium (56 FR 30266, July 1, 1991, effective January 1, 1993); and for antimony, beryllium, endrin, methylene chloride, nickel, (57 FR 31776, July 17,1992, effective August 17, 1992).

water. The Commonwealth lists its Maximum Contaminant Levels (MMCLs) in Section 22. Drinking Water Regulations, Code of Massachusetts Regulations, Title 310 (310 CMR 22.05 to 22.09), effective November 20, 1992. The Division of Water Supply is the enforcement authority. The MMCLs are also listed in Table 1 as applicable requirements for cleanup of Zone II groundwater and of groundwater that serves a public water supply well at the Annex. As with the SDWA MCLs, the MMCLs would also be relevant and appropriate requirements for remediation of the medium to high yield groundwater that could be a potential source of drinking water supply. The MMCLs are identical to the SDWA MCLs, with the exception of chlordane for which the SDWA MCL of 2 μg/L is stricter than the MMCL of 5 μg/L; consequently the SDWA MCL would be the applicable requirement (see Table 1).

The Commonwealth of Massachusetts has also established Groundwater Standards in the Massachusetts Contingency Plan (310 CMR 40, July 30, 1993, effective October 1, 1993), promulgated pursuant to Massachusetts General Law c. 21E. These standards apply to the cleanup of disposal sites and are developed using a Method 1 risk characterization approach (310 CMR 40.0970), which compares the current and reasonably foreseeable use of the groundwater at the disposal site to promulgated standards (MMCLs in 310 CMR 22; Groundwater Quality Standards in 314 CMR 6). The groundwater category (GW-1, GW-2, GW-3) identified for the site determines which standards apply. Category GW-1 groundwater is defined as groundwater within a Zone II; within a Wellhead Protection Area; within a potentially productive area; within Zone A of a Class A surface water body; within 500 feet or more of a public water system distribution pipeline; or within 500 feet of a private water supply well that is in compliance with pertinent regulations. Based on these definitions in 310 CMR 40.0932, certain areas of groundwater at the Annex would be in Category GW-1 established by the Department of Environmental Protections's Division of Water Supply, pursuant to 310 CMR 22.02. Consequently, the MCP Method 1 Groundwater Standards provided in the GW-1 column of 310 CMR 40.0974(2) and in Table 1 of this document will be considered applicable requirements for cleanup of these areas of contaminated groundwater at the Annex. GW-3 Groundwater Standards would be applicable requirements for the remediation of groundwater underlying the Annex that potentially discharges to surface waters and that is not a current or potential source of drinking water. These standards are presented in Table 2 for all of the detected chemicals in groundwater at the Annex. The GW-1 Groundwater Standards are identical to the SDWA MCLs and/or MMCLs for several of the chemicals detected at the Annex (see Table 1). The Commonwealth of Massachusetts has also established MCP Method 1 Groundwater Standards for chemicals for which a SDWA MCL or MMCL has not been promulgated, including acetone, chloroform, chromium VI, DDD, DDT, 1,3-dichlorobenzene, dieldrin, 2,4-dinitrotoluene, endosulfan B, methyl isobutyl ketone, 2-methylnaphthalene, naphthalene, silver, total petroleum hydrocarbons, and zinc. These standards would be ARAR for cleanup of these chemicals in groundwater used as drinking water at the site (see Table 1). According to 310 CMR 40.0983, if an MCP Method 1 Groundwater Standard has not been promulgated by the Department, a Licensed Site Professional may develop an MCP Method 2 Standard for the chemical, based on either background concentrations, non-cancer or cancer risk, or the Practical Quantitation Limit. The non-cancer health risk would be a

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex	
Chemical	MA Groundwater Standard GW-3[a]
Acetone	50,000
Alcohols (high molecular weight)	
Aluminum	
2-Amino-4,6-dinitrotoluene	
4-Amino-2,6-dinitrotoluene	
Antimony	300
Arsenic	400
Barium	
Benzene	7,000
Beryllium	50
α-BHC	
Bicyclohexyl	
2-Butanone	
Cadmium	10
Calcium	
Carbon disulfide	
α-Chlordane	2
Chlorobenzene	500
Chlorodifluoromethane	
Chloroform	10,000
Chloromethane	
Chromium (IV)	100
Chromium (Total)	2,000
Cobalt	
Copper	
Cyclohexanol	
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX	
Dacthal/DCPA	
p,p-DDD	6

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex	
Chemical	MA Groundwater Standard GW-3[a]
p,p-DDT	0.3
1,3-Dichlorobenzene	8,000
1,1-Dichloroethene	50,000
Dieldrin	0.1
N,N-Diethyl-3-methylbenzamide	
Dimethoxy dimethylsilane	
1,3-Dimethylbenzene/m-xylene	
1,4-Dimethylbenzene	
2,4-Dinitrotoluene	2,000
Dioctyl adipate	
Endosulfan, B	0.1
Endrin	5
Endrin aldehyde	
Ethylbenzene	4,000
Ethyl methyl benzene	
1-Ethyl-2-methylbenzene	
Heptachlor	1
Heptachor epoxide	2
Hexamethylcyclotrisiloxane	
2-Hexanone	
Hydrocarbons (all molecular weights)	
4-Hydroxyl-4-methyl-2-pentanone	
Indan/Hydrindene	
Iron	
Lead	30
Lindane	0.8
Magnesium	
Manganese	
Mercury	1
2-Methoxy-1-propene	

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex

Chemical	MA Groundwater Standard GW-3[a]
Methylene chloride	50,000
1-Methylindan	
Methyl isobutyl ketone	50,000
1-Methylnaphthalene	
2-Methylnaphthalene	3,000
Naphthalene	6,000
Nickel	80
Nitrate	
Nitrobenzene	
Nitroglycerine	
2-Nitrotoluene	
3-Nitrotoluene	
4-Nitrotoluene	
Oil and grease	
PCB-1254	0.3
Pentaerythritol tetranitrate/PETN	
Phosphate	
Potassium	
Selenium	80
Silver	7
Sodium	
Sulfate	
Sulfur	
Supraene/spinacene/squalene	
Tetrachloroethylene/tetrachloroethene	5,000
Tetrahydrofuran	
1,2,3,4-Tetramethylbenzene	
Toluene	50,000
Total petroleum hydrocarbons	50,000
1,1,1-Trichloroethane	50,000

Table 2. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of GW-3 Groundwater at the E&E Sites at the Sudbury Training Annex	
Chemical	MA Groundwater Standard GW-3[a]
Trichloroethylene/Trichloroethene	20,000
1,2,3-Trimethylbenzene	
Trimethylbenzenes	
1,3,5-Trinitrobenzene	
2,4,6-Trinitrotoluene	
Vanadium	
Xylene (total)	50,000
Zinc	900

[a] Code of Massachusetts Regulations, Title 310, Section 40.0974(2), Groundwater Standards for category GW-3 July 30, 1993, effective October 1, 1993.

concentration in drinking water of the chemical associated with 20% of an allowable daily dose. The cancer risk value would be the concentration of the chemical associated with an excess lifetime cancer risk of 10^{-6}.

The Commonwealth of Massachusetts has established MMCLs and Groundwater Standards of 15 μg/L and 50 μg/L for lead and arsenic, respectively, and an MMCL of 1,300 μg/L for copper. USEPA, under the SDWA, has promulgated action levels for lead and copper that are identical to the MMCLs and/or Groundwater Standard. The federal action levels are relevant and appropriate requirements for Superfund sites with contaminated groundwater. The MMCL for lead would be the applicable requirement for Zone II groundwater and for groundwater that serves a public water supply well. Massachusetts has also promulgated a stricter secondary MCL (SMCL) for copper of 1,000 μg/L that would be relevant and appropriate for groundwater cleanup at the site. Consequently, based on strictness, the SMCL would be the selected ARAR. Exceedance of the SDWA action levels indicates potential source water (groundwater) contamination and triggers the need to implement either optimal corrosion control for systems serving <50,000 people or source water monitoring and possible treatment, public education, and lead service line replacement for all systems. It is not equivalent to an MCL but is a treatment technique requirement. Upon exceedance, the water system is required to collect source water samples and submit the results to the Commonwealth of Massachusetts. Within six months of exceeding the action level, the water system is required to recommend in writing to the Commonwealth a proposed source water treatment. The Commonwealth of Massachusetts would then be required to analyze the monitoring results and treatment recommendation to determine the technology that would be most effective at reducing contaminant levels in water delivered to the user's tap. Follow-up source water and tap samples are to be taken within 12 months of the installation of the treatment and submitted to the Commonwealth. The Commonwealth will then establish maximum permissible lead levels in source water that the water system must maintain.

National Secondary Drinking Water Regulations have also been established under the SDWA in 40 CFR Part 143. The secondary standards are known as SMCLs, and are levels established to regulate the aesthetic qualities related to public acceptance of drinking water. The federal regulations are not enforceable but rather are intended to serve as guidelines for use by states. Therefore, they are not considered as potential ARARs but are listed in Table 1 as "to-be-considered" guidance. Massachusetts SMCLs that have been promulgated, pursuant to 310 CMR Section 22 (effective November 20, 1992) are legally enforceable and are relevant and appropriate for cleanup of groundwater at the Annex. The Massachusetts SMCLs for aluminum, iron, manganese, and sulfates would be relevant and appropriate requirements for cleanup of groundwater at the Annex (see Table 1).

2.1.2. Surface Water and Sediment

CERCLA §121(d)(2)(A) specifically states that remedial actions shall at least attain federal ambient water quality criteria (WQC) established under the Clean Water Act (CWA) if they are relevant and appropriate. In determining whether any WQC are relevant and appropriate, one must consider the "designated or potential use of the surface water, the environmental media affected, the purposes for which the criteria were developed, and the latest information available" [CERCLA §121(d)(2)(B)]. Federal WQC are derived for the protection of human

Table 3. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Surface Water at the E&E Sites at Sudbury Training Annex[a]

Chemical	Massachusetts/CWA WQC for Protection of Human Health[b]		Massachusetts/CWA WQC for Protection of Aquatic Organisms[c]	
	Consumption of Aquatic Organisms and Drinking Water[d]	Consumption of Aquatic Organisms Only[d]	Freshwater Acute[e]	Freshwater Chronic[f]
Acetone				
Aluminum				
Arsenic	0(0.018)	0(0.14)	360	190
Barium				
2-Butanone				
2-(2-N-Butoxyethoxy)ethanol				
Calcium				
Carbonic acid dimethyl ether				
Chromium				
Chromium (IV)			16	11
Copper			18[g]	12[g]
Dacthal/DCPA				
p,p-DDD	0(0.00059)	0(0.00059)		
p,p-DDE	0(0.00083)	0(0.00084)		
Dimethoxy dimethylsilane				
Dioctyl adipate				
2E1HXL				
Endosulfan sulfate	0.93	2.0		
Endrin	0.76	0.81	0.18	0.0023
Hexadecanoic acid/Palmitic acid				
Hexamethylcyclotrisiloxane				

Table 3. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Surface Water at the E&E Sites at Sudbury Training Annex[a]

Chemical	Massachusetts/CWA WQC for Protection of Human Health[b]		Massachusetts/CWA WQC for Protection of Aquatic Organisms[c]	
	Consumption of Aquatic Organisms and Drinking Water[d]	Consumption of Aquatic Organisms Only[d]	Freshwater Acute[e]	Freshwater Chronic[f]
Hydrocarbons (all molecular weights)				
4-Hydroxy-4-methyl-2-pentanone				
Iron				
Lead			82[g]	3.2[g]
Magnesium				
Manganese				
2-(2-Methoxyethoxy)ethanol				
Methylene chloride	0(4.7)	0(1600)		
3-Nitrotoluene				
Oil and grease[h]				
Phenol	21,000	4,600,000		
Phenoxyacetic acid				
2-Phenoxyethanol				
2-(2-N-Phenoxyethoxy)ethanol				
Phosphate				
Potassium				
Selenium			20	5
Silver			4.1[g]	
Sodium				
Sulfur				
1,1,2,2-Tetrachloroethane	0(0.17)	0(11)		

Table 3. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Surface Water at the E&E Sites at Sudbury Training Annex[a]

Chemical	Massachusetts/CWA WQC for Protection of Human Health[b]		Massachusetts/CWA WQC for Protection of Aquatic Organisms[c]	
	Consumption of Aquatic Organisms and Drinking Water[d]	Consumption of Aquatic Organisms Only[d]	Freshwater Acute[e]	Freshwater Chronic[f]
Tetracosane				
Toluene	6800	200,000		
1,1,2-Trichloroethane	0(0.60)	0(42)		
2,2,4-Trimethyl-1,3-pentanediol				
Vanadium				
Xylene				
Zinc			120[g]	110[g]

[a] This table provides ARARs for all chemicals historically detected in surface water at Group IB site, Fort Devens (based on monitoring data from USAEC Installation Restoration Database Management Information System, Inc. as of December 21, 1993). All values in this table are given in μg/L. The underlined values indicate the strictest ARAR for each chemical.

[b] WQC = Water Quality Criteria from Code of Massachusetts Regulation, Title 314, Section 4.05(5)(e)/U.S. Environmental Protection Agency, 57 FR 60848, December 22, 1992.

[c] WQC = Water Quality Criteria from Code of Massachusetts Regulation, Title 314, Section 4.05(5)(e)/U.S. Environmental Protection Agency, 57 FR 60848, December 22, 1992.

[d] The criterion value of zero for all potential carcinogens is listed in the table. Concentrations in parentheses for potential caricnogens correspond to a risk of 10^{-6}.

[e] One-hour average concentration not to be exceeded more than once every 3 years.

[f] Four-hour average concentration not to be exceeded more than once every 3 years.

[g] Water hardness dependent criteria (100 mg/L as $CaCO_3$).

[h] See Section 2.1.2. of the text for the Commonwealth narrative criterion.

health from the consumption of contaminated drinking water and/or aquatic organisms and for the protection of freshwater aquatic organisms. The Code of Massachusetts Regulations, Title 314, Chapter 4, Surface Water Quality Standards, effective February 28, 1992, classifies the surface waters of the Commonwealth according to the uses of those waters. Chapter 4 also prescribes the water quality criteria necessary to achieve those classifications and specifies other policies, including the prohibition of discharges to those waters where necessary. The Annex lies within the Concord River Basin which has a Class B Waterway classification. Taylor Brook, Honey Brook, Marlboro Brook, and other unnamed streams and tributaries flow through the Annex discharging either directly or indirectly into the Assabet or Concord Rivers. Both of these rivers are Class B waters. The northern portion of the Annex flows directly to the Assabet River via Taylor Brook and its tributaries. The southwestern and western sides of the Annex drain primarily into Lake Boon or White Pond, located outside the southwest boundary of the Annex, which, in turn, discharges into the Assabet River. White Pond is listed as a Class A water in Table 23 of Chapter 4 of the Code. None of the sites of concern for this document drain into White Pond. The detached south portion of the Annex drains into Hop Brook, which discharges into the Concord River. Puffer Pond, Willis Pond, Cutting Pond, and Vose Pond are located within the boundaries of the Annex (EEI 1993). Because none of these ponds are listed in Table 23 of Chapter 4 of the Code, they are automatically classified as Class B waters (Hogan 1992). Class B waters are designated as habitat for fish, other aquatic and wildlife, and for primary and secondary contact recreation. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value [314 CMR 4.05(3)(b)]. The state surface water minimum criteria for Class B waters are consistent with the federal WQC (Hogan 1992). The other state criteria are narrative except for those pollutants that have prescribed minimum water quality criteria established by EPA pursuant to Section 304(a) of the federal Clean Water Act [314 CMR 4.05(5)(e)], and except where a site-specific limit is established pursuant to 314 CMR 4.05(5)(e)(1-4). The Commonwealth narrative criterion for oil and grease states that Class B waters "shall be free from oil, grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course, or are deleterious or become toxic to aquatic life" [314 CMR 4.05(3)(b)(5)].

Table 3 lists Massachusetts and federal CWA WQC for the protection of human health for the consumption of aquatic organisms and drinking water and for the consumption of aquatic organisms alone and Massachusetts and federal CWA WQC for the protection of aquatic organisms, acute and chronic for the chemicals detected in surface waters at the Annex. The Massachusetts WQC would be considered applicable for the remediation of contamination in the on-site surface water bodies of the Concord River Basin; the CWA WQC are relevant and appropriate requirements for remediation of these water bodies.

Massachusetts also includes antidegradation provisions for surface waters, codified at 314 CMR 4.04 (1990). The regulation requires the protection of existing uses and states that "In all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." The policy is an anti-pollution requirement rather than a cleanup requirement and would not be considered a chemical-specific ARAR. In addition, it would not the policy itself that would be ARAR but the standards that are promulgated to carry out the policy that would ARAR, the uses and associated criteria for specified water

bodies. Promulgation simply means that these standards have gone through rulemaking and public notice and comment.

There are no set maximum allowable residual levels for chemicals in sediments under federal or Massachusetts state law.

2.1.3. Soil

There are no set maximum allowable residual levels for chemicals in soils under federal law.

The Commonwealth of Massachusetts has established Soil Standards in the Massachusetts Contingency Plan (310 CMR 40, July 30, 1993, effective October 1, 1993), promulgated pursuant to Massachusetts General Law c. 21E. These standards apply to the cleanup of disposal sites and are developed using either a Method 1 (310 CMR 40.0975) or 2 (310 CMR 40.0985) risk characterization approach. MCP Method 1 involves the characterization of risk through the use of promulgated standards and considers the risk from direct exposure to the chemical in soil and the potential impacts on the groundwater through leaching. MCP Method 2 involves the application of site-specific methodologies and considers the risk from direct contact with the soil. The category of soil (S-1, S-2, S-3) at the exposure point determines the applicable Soil Standard. The soil categories are based on the potential for exposure, which involves the frequency of use, the intensity of use, and the accessibility for adults and/or children (310 CMR 40.0933). Table 4 provides the MCP Method 1 Soil Standards for GW-1 groundwater and all three soil categories and the MCP Method 2 Soil Standards for all three soil categories for the chemicals detected in soils at the E&E sites at the Annex. Table 5 provides the MCP Method 1 Soil Standards for GW-3 groundwater and all three soil categories and the MCP Method 2 Soil Standards for all three soil categories for these chemicals. 310 CMR 40.0933(9) provides a matrix to be used to identify the appropriate soil category for exposure potential. Based on the selected soil category, the values provided in Tables 4 or 5 would be considered applicable requirements for cleanup of contaminated soil at the Annex. According to 310 CMR 40.0984, if an MCP Method 1 Soil Standard has not been promulgated by the Department, a Potentially Responsible Party may develop an MCP Method 2 Standard for the chemical, based on several factors, including the background concentrations, non-cancer or cancer risk using the equations provided in the regulation, or the Practical Quantitation Limit. The non-cancer health risk would be a concentration in soil of the chemical associated with 20% of an allowable daily dose. The cancer risk value would be the concentration of the chemical associated with an excess lifetime cancer risk of 10^{-6}.

2.2. OTHER GUIDANCE TO BE CONSIDERED

2.2.1. Groundwater

Additional TBC guidance values are provided in Table 1 for any groundwater contaminant for which a final SDWA or Commonwealth MCL/MCLG, SMCL, or Groundwater Standard is yet to be promulgated. In the absence of federal- or state-promulgated ARARs, or in the case where ARARs are not adequately protective, EPA states a preference for Office of Drinking Water (ODW) Health Advisories (HAs), Reference Doses (RfDs) for systemic toxi

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Acenaphthene	20	20	20	1,000	2,500	5,000
Acetone	3	3	3	500	1,000	5,000
Alcohol (high molecular weight)						
Aldehydes						
Aluminum						
4-Amino-2,6-dinitrotoluene						
Anthracene	1,000	1,000	1,000	1,000	2,500	5,000
Antimony	10	40	40	10	40	40
Arsenic	30	30	30	30	30	30
Barium						
Benzo(a)anthracene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(a)pyrene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluorene						
Benzo(ghi)perylene	100	100	100	1,000	2,500	2,500
Benzo(e)pyrine						
Benzo(k)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(j)fluoranthene						
Beryllium	0.4	0.8	3	0.4	0.8	3
β-BHC						
Δ-BHC						
2-Butanone						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Cadmium	30	80	80	30	80	80
Calcium						
Camphor						
Carbazole						
Carbonic acid dimethyl ether						
α-Chlordane						
μ-Chlordane						
Chlorobenzene	8	8	8	500	1,000	2,500
Chloroform	0.1	0.1	0.1	100	200	500
Chromium	1,000	2,500	5,000	1,000	2,500	5,000
Chrysene	0.7	0.7	0.7	0.7	0.7	0.7
Cobalt						
Copper						
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX						
Cyclotetramethylene-tetranitramine/HMX						
Dacthal/DCPA						
p,p-DDD	2	3	10	2	3	10
p,p-DDE	2	2	9	2	2	9
p,p-DDT	2	2	9	2	2	9
Dibenzofuran						
1,2-Dichloroethane	0.05	0.05	0.05	10	20	60

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Dieldrin	0.03	0.04	0.1	0.03	0.04	0.2
Diethyl phthalate	100	100	100	1,000	2,500	5,000
1,3-Dimethylcyclohexane						
1,4-Dimethylcyclohexane						
1,3-Dimethylbenzene/m-xylene						
1,5-Dimethylnaphthalene						
2,4-Dinitrotoluene						
2,6-Dinitrotoluene						
Dioctyl adipate						
Endosulfan, A and sulfate						
Endosulfan, B						
Endrin	0.6	0.6	0.6	6	10	10
Ethylbenzene	80	80	80	500	1,000	2,500
1-Ethyl-2-methylbenzene						
Fluoranthene	600	600	600	900	2,000	5,000
Fluorene	400	400	400	800	2,000	5,000
Heptachlor	0.1	0.2	0.7	0.1	0.2	0.7
Heptachlor epoxide	0.06	0.09	0.3	0.06	0.09	0.3
Heptacosane						
Heptadecane						
Hexachlorobiphenyls						
Hexadecane						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Hexadecanoic acid/Palmitic acid						
Hexamethylcyclotrisiloxane						
2,2,4,4,7,7-Hexamethyloctahydro-1H-indene						
2-Hexanone						
Hexatriacontane						
Hydrocarbons (all molecular weights)						
Indeno(1,2,3-cd)pyrene						
Iron						
Isophorone						
Lead	300	600	600	300	600	600
Lindane	0.1	0.1	0.1	0.4	0.6	2
Linoleic acid						
Magnesium						
Manganese						
Mercury	10	60	60	10	60	60
Mesityl oxide						
Methylene chloride	0.1	0.1	0.1	100	200	700
4-Methyl-1-(1-methylethyl)-bicyclo[3,1,0]hex-2-ene						
2-Methylnaphthalene	0.7	0.7	0.7	1,000	2,500	2,500
3-Methylpentane						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Naphthalene	4	4	4	100	2,500	2,500
Nickel	300	700	700	300	700	700
Nitroglycerine						
2-Nitrotoluene						
3-Nitrotoluene						
Nonane						
Octadecanoic acid/ stearic acid						
Octane						
Oil and grease						
PCB-1242	2	2	2	2	2	2
PCB-1248	2	2	2	2	2	2
PCB-1254	2	2	2	2	2	2
PCB-1260	2	2	2	2	2	2
2,2',4,4',5-Pentachloro-1,1'-biphenyl						
2,3',4,4',5-Pentachloro-1,1'-biphenyl						
Pentaerythritol tetranitrate/PETN						
Pentatriacontane						
Petroleum distillates						
Phenanthrene	700	700	700	1,000	2,500	2,500
Phenol	60	60	60	500	1,000	2,500
1-Phenylpropane/n-propylbenzene						

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Phosphate						
α-Pinene						
Potassium						
2-Propanol						
Pyrene	500	500	500	700	2,000	5,000
Selenium	300	2,500	2,500	300	2,500	2,500
Silver	100	200	200	100	200	200
Sodium						
Steroids						
Sulfur						
Tetrachloroethylene/ tetrachloroethene	1	1	1	200	300	1,000
1,2,3,4-Tetramethylbenzene						
2,6,10,14-Tetramethylpentadecane						
Thallium	8	30	100	8	30	100
Toluene	80	80	80	500	1,000	2,500
Total organic carbon						
Total petroleum hydrocarbons	500	2,500	5,000	500	2,500	5,000
Total phosphates						
2,4,5-TP/silvex						
1,1,1-Trichloroethane	10	10	10	100	500	500
1,1,2-Trichloroethane	0.3	0.3	0.3	2	3	10

Table 4. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-1) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-1	MCP Method 1[b] S-2 Soil + GW-1	MCP Method 1[b] S-3 Soil + GW-1	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Trichloroethylene	0.5	0.5	0.5	70	100	500
Trichlorofluoromethane						
1,3,5-Trimethylbenzene						
1,7,7-Trimethylbicyclo[2,2,1] hept-2-ene						
1,1,3-Trimethylcyclohexane						
2,4,6-Trinitrotoluene						
Vanadium						
Xylenes, total	500	800	800	500	1,000	2,500
Zinc	2,500	2,500	5,000	2,500	2,500	5,000

[a] All values are in μg/g, Code of Massachusetts Regulations Title 310, Section 40.0975(6)(a-c); Section 40.0985(6), July 30, 1993; effective October 1, 1993.
[b] Direct contact exposure- and leachate-based soil concentrations.
[c] Direct contact exposure-based soil concentrations.

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Acenaphthene	1,000	2,000	2,000	1,000	2,500	5,000
Acetone	60	60	60	500	1,000	5,000
Alcohol (high molecular weight)						
Aldehydes						
Aluminum						
4-Amino-2,6-dinitrotoluene						
Anthracene	1,000	1,000	1,000	1,000	2,500	5,000
Antimony	10	40	40	10	40	40
Arsenic	30	30	30	30	30	30
Barium						
Benzo(a)anthracene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(a)pyrene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(b)fluorene						
Benzo(ghi)perylene	30	30	30	1,000	2,500	2,500
Benzo(e)pyrine						
Benzo(k)fluoranthene	0.7	0.7	0.7	0.7	0.7	0.7
Benzo(j)fluoranthene						
Beryllium	0.4	0.8	3	0.4	0.8	3
β-BHC						
Δ-BHC						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
2-Butanone						
Cadmium	30	80	80	30	80	80
Calcium						
Camphor						
Carbazole						
Carbonic acid dimethyl ether						
α-Chlordane						
μ-Chlordane						
Chlorobenzene	40	40	40	500	1,000	2,500
Chloroform	100	200	300	100	200	500
Chromium	1,000	2,500	5,000	1,000	2,500	5,000
Chrysene	0.7	0.7	0.7	0.7	0.7	0.7
Cobalt						
Copper						
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX						
Cyclotetramethylenetetranitramine/HMX						
Dacthal/DCPA						
p,p-DDD	2	3	10	2	3	10
p,p-DDE	2	2	9	2	2	9
p,p-DDT	2	2	9	2	2	9

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Dibenzofuran						
1,2-Dichloroethane	10	20	60	10	20	60
Dieldrin	0.03	0.04	0.1	0.03	0.04	0.2
Diethyl phthalate	0.7	0.7	0.7	1,000	2,500	5,000
1,3-Dimethylcyclohexane						
1,4-Dimethylcyclohexane						
1,3-Dimethylbenzene/m-xylene						
1,5-Dimethylnaphthalene						
2,4-Dinitrotoluene						
2,6-Dinitrotoluene						
Dioctyl adipate						
Endosulfan, A and sulfate						
Endosulfan, B						
Endrin	1	1	1	6	10	10
Ethylbenzene	500	500	500	500	1,000	2,500
1-Ethyl-2-methylbenzene						
Fluoranthene	600	600	600	900	2,000	5,000
Fluorene	900	400	1,000	800	2,000	5,000
Heptachlor	0.1	0.2	0.7	0.1	0.2	0.7
Heptachlor epoxide	0.06	0.09	0.3	0.06	0.09	0.3
Heptacosane						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Heptadecane						
Hexachlorobiphenyls						
Hexadecane						
Hexadecanoic acid/Palmitic acid						
Hexamethylcyclotrisiloxane						
2,2,4,4,7,7-Hexamethyloctahydro-1H-indene						
2-Hexanone						
Hexatriacontane						
Hydrocarbons (all molecular weights)						
Indeno(1,2,3-cd)pyrene						
Iron						
Isophorone						
Lead	300	600	600	300	600	600
Lindane	0.4	0.5	0.5	0.4	0.6	2
Linoleic acid						
Magnesium						
Manganese						
Mercury	10	60	60	10	60	60
Mesityl oxide						
Methylene chloride	100	200	700	100	200	700

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
4-Methyl-1-(1-methylethyl)-bicyclo[3,1,0]hex-2-ene						
2-Methylnaphthalene	7	7	7	1,000	2,500	2,500
3-Methylpentane						
Naphthalene	100	1,000	1,000	100	2,500	2,500
Nickel	300	700	700	300	700	700
Nitroglycerine						
2-Nitrotoluene						
3-Nitrotoluene						
Nonane						
Octadecanoic acid/ stearic acid						
Octane						
Oil and grease						
PCB-1242	2	2	2	2	2	2
PCB-1248	2	2	2	2	2	2
PCB-1254	2	2	2	2	2	2
PCB-1260	2	2	2	2	2	2
2,2',4,4',5-Pentachloro-1,1'-biphenyl						
2,3',4,4',5-Pentachloro-1,1'-biphenyl						
Pentaerythritol tetranitrate/PETN						
Pentatriacontane						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Petroleum distillates						
Phenanthrene	100	100	100	1,000	2,500	2,500
Phenol	500	500	500	500	1,000	2,500
1-Phenylpropane/n-propylbenzene						
Phosphate						
α-Pinene						
Potassium						
2-Propanol						
Pyrene	500	500	500	700	2,000	5,000
Selenium	300	2,500	2,500	300	2,500	2,500
Silver	100	200	200	100	200	200
Sodium						
Steroids						
Sulfur						
Tetrachloroethylene/ tetrachloroethene	200	300	1,000	200	300	1,000
1,2,3,4-Tetramethylbenzene						
2,6,10,14-Tetramethylpentadecane						
Thallium	8	30	100	8	30	100
Toluene	500	1,000	2,500	500	1,000	2,500
Total organic carbon						

Table 5. Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for Cleanup of Soil (S-1, S-2, S-3, GW-3) at the E&E Sites at Sudbury Training Annex[a]

Chemical	MCP Method 1[b] S-1 Soil + GW-3	MCP Method 1[b] S-2 Soil + GW-3	MCP Method 1[b] S-3 Soil + GW-3	MCP Method 2[c]		
				S-1 Soil	S-2 Soil	S-3 Soil
Total petroleum hydrocarbons	500	2,500	5,000	500	2,500	5,000
Total phosphates						
2,4,5-TP/silvex						
1,1,1-Trichloroethane	100	500	500	100	500	500
1,1,2-Trichloroethane	2	3	10	2	3	10
Trichloroethylene	70	100	500	70	100	500
Trichlorofluoromethane						
1,3,5-Trimethylbenzene						
1,7,7-Trimethylbicyclo[2,2,1] hept-2-ene						
1,1,3-Trimethylcyclohexane						
2,4,6-Trinitrotoluene						
Vanadium						
Xylenes, total	500	1,000	2,500	500	1,000	2,500
Zinc	2,500	2,500	5,000	2,500	2,500	5,000

[a] All values are in $\mu g/g$, Code of Massachusetts Regulations Title 310, Section 40.0975(6)(a-c); Section 40.0985(6), July 30, 1993; effective October 1, 1993.
[b] Direct contact exposure- and leachate-based soil concentrations.
[c] Direct contact exposure-based soil concentrations.

cants and slope factors (SFs) for carcinogens (USEPA 1988; 53 FR 51394, December 21, 1988). RfDs and SFs are available from the EPA IRIS database (USEPA 1994) and/or the annual EPA Health Effects Assessment Summary Tables (HEAST) (USEPA 1993a). Toxicity values for all detected chemicals at the E&E sites at the Annex are provided in Table 6.

Drinking Water HAs. Table 1 provides Lifetime Health Advisories and 10^{-6} cancer risk levels (USEPA 1993b) for all detected chemicals for which values are available. The Lifetime Health Advisories for chloromethane, dacthal, RDX, and 2,4,6-trinitrotoluene are the strictest among the TBC values and would, therefore, be used as guidance for cleanup of groundwater at the Annex. The Drinking Water Equivalent Level for sodium is the strictest among the TBC values and would, therefore, be used as guidance for cleanup of groundwater at the E&E sites at the Annex. These values are calculated assuming that an individual receives 80% of his exposure from sources other than consumption of drinking water.

SDWA NIPDWR/Proposed MCLs. Pursuant to the SDWA amendments of 1986, EPA has proposed an MCL and MCLG for sulfate (400,000/500,000 μg/L). The proposed value appeared in 55 FR 30370 (July 25, 1990). EPA is deferring setting a final MCL/MCLG for sulfate pending further study (57 FR 31776, July 17, 1992). However, it should be noted that the current stricter Massachusetts SMCL of 250,000 μg/L would be the relevant and appropriate requirement at this time. National Interim Primary Drinking Water Regulations (NIPDWR) have been established for arsenic and total trihalomethanes (40 FR 59570, December 24, 1975, effective June 24, 1976). The NIPDWR for arsenic matches the MMCL (see Table 1). According to the recent EPA Regulatory Agenda, an MCL for arsenic is expected to be proposed in September 1994 (58 FR 25034, April 26, 1993), with a final rule expected in September 1996. These values are currently listed as TBC guidance in Table 1; however, when the proposed MCLs are promulgated, they will be considered applicable or relevant and appropriate for cleanup of these chemicals in groundwater at the Annex.

Massachusetts ORSGs. The MDEP Office of Research and Standards issues guidance for chemicals for which state MCLs have not been promulgated. These guidelines apply to non-chlorinated water supplies and represent a level at or below which adverse, non-cancer health effects are unlikely to occur and which generally has associated with it an excess lifetime cancer risk of less than or equal to one in one million. SDWA MCLs that have been promulgated by EPA but are not yet effective are listed as ORSGs. ORSGs are listed in Table 1 for all detected chemicals for which values are available. The ORSG for tetrahydrofuran could be used as a guidance level for remediating groundwaters contaminated with this chemical at the Annex.

Calcium, Cobalt, Magnesium, Potassium, Sulfur, Vanadium. In lieu of any available criteria for cleanup of these elements, which can be considered essential nutrients, naturally-occurring levels (background) could be considered as a guidance for establishing cleanup levels.

In lieu of any available criteria for cleanup of the remaining chemicals detected in groundwater at the Annex, the USAEC will develop cleanup criteria using a risk assessment approach and the appropriate RfDs or SFs given in Table 6.

2.2.2. Surface Water and Sediment

Lead. For assessing the risk from exposure to lead in the sediments of the surface water bodies at the Annex, EPA's Uptake/Biokinetic Model can be used, upon approval of the EPA Regional Project Manager for the Annex. The model provides a multimedia exposure approach to estimate the percentage (may vary from region to region) of the exposed population (children, ages 0-6) with blood lead levels above a critical value of 10 μg/dL.

Dieldrin, Endrin, Fluoranthene, Phenanthrene. EPA's Office of Science and Technology has proposed Sediment Quality Criteria (SQC) for the protection of benthic organisms (59 FR 2652, January 18, 1994). The criteria states that benthic organisms should be acceptably protected in freshwater sediments containing 11 μg dieldrin/g organic carbon; 4.2 μg endrin/g organic carbon; 620 μg fluoranthene/g organic carbon; and 180 μg phenanthrene/g organic carbon. These criteria will apply to sediments with $\geq$ 0.2% organic carbon. EPA sources indicate that criteria for metals are currently under development.

In lieu of any available criteria for cleanup of the chemicals detected in surface waters at the Annex for which WQC are not available and for chemicals detected in contaminated sediments for which SQC are not available, the USAEC will develop surface water and sediment cleanup criteria using a risk assessment approach and the appropriate RfDs or SFs given in Table 6. The methodology outlined in RAGS (USEPA 1989) may be utilized to quantitate exposure pathways and risk to individuals from exposure via the pathways of concern at a particular site. In addition, cleanup criteria addressing ecological risk should be developed.

2.2.3. Soil

Lead. EPA has suggested cleanup values for lead in soils based on studies of blood lead levels in exposed children. The EPA OSWER Directive 9355.4-02 (dated September 7, 1989) recommends a cleanup level for soils of 500 to 1000 ppm lead. In addition, the Uptake/Biokinetic Model as described in Section 2.2.2 above may be used to assess the risk from lead exposure for current- or future-use exposure scenarios.

In lieu of any available criteria for cleanup of the chemicals detected in soils at the E&E Sites at the Annex for which Massachusetts MCP Method 1 and/or 2 Soil Standards are unavailable, the USAEC will develop soil cleanup criteria using a risk assessment approach and the appropriate RfDs or SFs given in Table 6. The methodology outlined in RAGS (USEPA 1989) may be utilized to quantitate exposure pathways and risk to individuals from exposure via the pathways of concern at a particular site. EPA Region IV has also provided some interim guidance to be used in determining the risks associated with dermal exposure to contaminated soils: a) dermal absorption factors of 1.0% for organics and 0.1% for inorganics; b) soil to skin adherence factors ranging from 0.2 to 1.0 mg/cm^2 (these factors differ from RAGS, based on new data) (USEPA 1992). Guidance can also be obtained from EPAs Dermal Exposure Assessment: Principles and Applications (EPA/600/8-91/011B, January 1992). Again, approval of the EPA Regional Project Manager for the Annex must be obtained for using these factors in the risk calculations.

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
Acenaphthene	6.0E-02	-	-	-	-
Acenaphthylene	-	-	-	-	-
Acetone	1.0E+00	-	-	-	D
Alcohol (high molecular weight)	-	-	-	-	-
Aldehydes	-	-	-	-	-
Aluminum	-	-	-	-	-
4-Amino-2,6-dinitrotoluene	-	-	-	-	-
4-Amino-4,6-dinitrotoluene	-	-	-	-	-
Anthracene	3.0E-01	-	-	-	D
Antimony	4.0E-04	-	-	-	-
Arsenic	3.0E-04	-	5.0E-05	5.0E-01	A
Athraquinone/9,10-anthracendione	-	-	-	-	-
Barium	7.0E-02	5.0E-04	-	-	-
BBNTHF	-	-	-	-	-
7H-Benz(de)anthracen-7-one	-	-	-	-	-
Benzene	-	-	2.9E-02	2.9E-02	A
Benzo(a)anthracene	-	-	-	-	-
Benzo(a)pyrene	-	-	7.3E+00	-	B2
Benzo(b)fluoranthene	-	-	-	-	B2
Benzo(b)fluorene	-	-	-	-	-
Benzo(ghi)fluoranthene	-	-	-	-	-
Benzo(ghi)perylene	-	-	-	-	D
Benzo(e)pyrine	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	B2
Benzo(j)fluoranthene	-	-	-	-	-
Beryllium	5.0E-03	-	4.3E+00	8.4E+00	B2
α-BHC	-	-	6.3E+00	6.3E+00	B2
ß-BHC	-	-	1.8E+00	1.8E+00	C
Δ-BHC	-	-	-	-	D
Bicyclohexyl	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
N,N-*Bis*(2-hydroxyethyl)dodecanamide	-	-	-	-	-
2-Butanone	-	-	-	-	-
2-(2-N-Butoxyethoxy)ethanol	-	-	-	-	-
3-(T-Butyl)phenol	-	-	-	-	-
Cadmium	5.0E-04	-	-	6.1E+00	B1
Calcium	-	-	-	-	-
Camphor	-	-	-	-	-
Carbazole	-	-	2.0E-02	-	B2
Carbon disulfide	1.0E-01	1.0E-02	-	-	-
Carbonic acid dimethyl ether	-	-	-	-	-
α-Chlordane	6.0E-05	-	1.3E+00	1.3E+00	B2
μ-Chlordane	6.0E-05	-	1.3E+00	1.3E+00	B2
Chlorobenzene	2.0E-02	2.0E-02	-	-	D
Chloroform	1.0E-02	-	6.1E-03	8.1E-02	B2
Chloromethane	-	-	1.3E-02	6.3E-03	C
Chromium (IV)	5.0E-03	4.1E+01	-	-	A
Chromium (total)	1.0E+00	-	-	-	-
Chrysene	-	-	-	-	B2
Cobalt	-	-	-	-	-
Copper	-	-	-	-	D
Cyclohexanol	-	-	-	-	-
Cyclonite/hexahydro-1,3,5-trinitro-1,3-5-triazine/RDX	3.0E-03	-	1.1E-01	-	C
Cyclotetramethylenetetranitramine/HMX	-	-	-	-	-
Dacthal/DCPA	5.0E-01	-	-	-	-
p,p-DDD	-	-	2.4E-01	-	B2
p,p-DDE	-	-	3.4E-01	-	B2
p,p-DDT	5.0E-04	-	3.4E-01	3.4E-01	B2
Dibenzo(a,h)anthracene	-	-	-	-	B2
Dibenzofuran	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
1,3-Dichlorobenzene	-	-	-	-	D
1,1-Dichloroethane	1.0E-01	5.0E-01	-	-	C
1,2-Dichloroethane	-	-	9.1E-02	9.1E-02	B2
Dieldrin	5.0E-05	-	1.6E+01	1.6E+01	B2
N,N-Diethyl-3-methylbenzamide	-	-	-	-	-
Diethyl phthalate	8.0E-01	-	-	-	D
Dimethyoxy dimethylsilane	-	-	-	-	-
1,3-Dimethylbenzene/m-xylene	2.0E+00	-	-	-	-
1,4-Dimethylbenzene	-	-	-	-	-
Dimethylbenzene sulfonamide	-	-	-	-	-
1,3-Dimethylcyclohexane	-	-	-	-	-
1,4-Dimethylcyclohexane	-	-	-	-	-
1,5-Dimethylnaphthalene	-	-	-	-	-
2,4-Dinitrotoluene	2.0E-03	-	6.8E-01	-	B2
2,6-Dinitrotoluene	1.0E-03	-	6.8E-01	-	B2
Dioctyl adipate	-	-	-	-	-
Dodecanoic acid/lauic acid	-	-	-	-	-
2E1HXL	-	-	-	-	-
1-Eicosanol	-	-	-	-	-
Endosulfan A	6.0E-03	-	-	-	-
Endosulfan B	-	-	-	-	-
Endosulfan sulfate	-	-	-	-	-
Endrin	3.0E-04	-	-	-	D
Endrin aldehyde	-	-	-	-	-
Ethylbenzene	1.0E-01	1.0E+00	-	-	D
Ethyl methyl benzene	-	-	-	-	-
1-Ethyl-2-methylbenzene	-	-	-	-	-
Fluoranthene	4.0E-02	-	-	-	D
Fluorene	4.0E-02	-	-	-	D
Heptachlor	5.0E-04	-	4.5E+00	4.5E+00	B2

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
Heptachlor epoxide	1.3E-05	-	9.1E+00	9.1E+00	B2
Heptacosane	-	-	-	-	-
Heptadecane	-	-	-	-	-
Hexachlorobiphenyls	-	-	-	-	-
Hexadecane	-	-	-	-	-
Hexadecanoic acid/Palmitic acid	-	-	-	-	-
Hexamethylcyclotrisiloxane	-	-	-	-	-
2,2,4,4,7,7-Hexamethyloctahydro-1H-indene	-	-	-	-	-
2-Hexanone	-	-	-	-	-
Hexatriacontane	-	-	-	-	-
Hydrocarbons (all molecular weights)	-	-	-	-	-
4-Hydroxyl-4-methyl-2-pentanone	-	-	-	-	-
Indan/Hydrindene	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	B2
Iron	-	-	-	-	-
Isophorone	2.0E-01	-	9.5E-04	-	C
Lead	-	-	-	-	B2
Lindane	3.0E-04	-	1.3E+00	-	B2
Linoleic acid	-	-	-	-	-
Magnesium	-	-	-	-	-
Manganese	1.0E-01 [5.0E-03 (water)]	5.0E-05	-	-	D
Mercury	3.0E-04	3.0E-04	-	-	D
Mesityl oxide	-	-	-	-	-
2-(2-Methoxyethoxy)ethanol	-	-	-	-	-
2-Methoxy-1-propene	-	-	-	-	-
Methylene chloride	6.0E-02	3.0E+00	7.5E-03	-	B2
1-Methylindan	-	-	-	-	-
Methyl isobutyl ketone	8.0E-02	8.0E-02	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
4-Methyl-1-(1-methylethyl)-bicyclo[3,1,0]hex-2-ene	-	-	-	-	-
1-Methylnapthalene	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-
4-Methylphenanthrene	-	-	-	-	-
3-Methylpentane	-	-	-	-	-
4-Methylphenol	-	-	-	-	-
2-Methylpropanoic acid, 3-hydroxy-2,4,4-trimethylpentyl ester	-	-	-	-	-
7-Methyltridecane	-	-	-	-	-
Myristic acid/tetradecanoic acid	-	-	-	-	-
Naphthalene	-	-	-	-	D
Nickel	2.0E-02	-	-	-	-
Nitrate	1.6E+00	-	-	-	-
Nitrobenzene	5.0E-04	2.0E-03	-	-	D
Nitroglycerine	-	-	-	-	-
N-Nitrosodipropylamine	-	-	4.9E-03	-	B2
2-Nitrotoluene	1.0E-02	-	-	-	-
3-Nitrotoluene	1.0E-02	-	-	-	-
4-Nitrotoluene	1.0E-02	-	-	-	-
Nonadecane	-	-	-	-	-
Nonane	-	-	-	-	-
Octadecanoic acid/ stearic acid	-	-	-	-	-
Octane	-	-	-	-	-
Oil and grease	-	-	-	-	-
PAHs	-	-	-	-	-
PCB-1242	-	-	7.7E+00	-	B2
PCB-1248	-	-	7.7E+00	-	B2
PCB-1254	-	-	7.7E+00	-	B2
PCB-1260	-	-	7.7E+00	-	B2
2,2',4,4',5-Pentachloro-1,1'-biphenyl	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
2,3',4,4',5-Pentachloro-1,1'-biphenyl	-	-	-	-	-
Pentadecanoic acid	-	-	-	-	-
Pentaerythritol tetranitrate/PETN	-	-	-	-	-
Pentatriacontane	-	-	-	-	-
Petroleum distillates	-	-	-	-	-
Phenanthrene	-	-	-	-	D
Phenol	6.0E-01	-	-	-	D
Phenol-D5	-	-	-	-	-
Phenoxyacietic acid	-	-	-	-	-
2-Phenoxyethanol	-	-	-	-	-
2-(2-N-Phenoxyethoxy)ethanol	-	-	-	-	-
1-Phenylpropane/n-propylbenzene	-	-	-	-	-
Phosphate	-	-	-	-	-
α-Pinene	-	-	-	-	-
Potassium	-	-	-	-	-
2-Propanol	-	-	-	-	-
Pyrene	3.0E-02	-	-	-	D
Selenium	5.0E-03	-	-	-	D
Silver	5.0E-03	-	-	-	D
Sodium	-	-	-	-	-
Steroids	-	-	-	-	-
(3β)-Stigmast-5-en-3-ol	-	-	-	-	-
Sulfur	-	-	-	-	-
Supraene/spinacene/squalene	-	-	-	-	-
1,1,2,2-Tetrachloroethane	-	-	2.0E-01	2.0E-01	C
Tetrachloroethylene/tetrachloroethene	1.0E-02	-	-	-	B2
Tetracosane	-	-	-	-	-
1,2,3,4-Tetramethylbenzene	-	-	-	-	-
2,6,10,14-Tetramethylpentadecane	-	-	-	-	-
Thallium	-	-	-	-	-

Table 6. Reference Doses (RfDs), Reference Concentrations (RfCs), and Carcinogen Slope Factors (SF) for Chemicals Detected at the E&E Sites at Sudbury Training Annex[a]

Chemical	Oral RfD[b] (mg/kg/day)	Inhalation RfC[c] (mg/m^3)	Oral SF[d] $(mg/kg/day)^{-1}$	Inhalation SF $(mg/kg/day)^{-1}$	Weight-of-Evidence Class
Toluene	2.0E-01	4.0E-01	-	-	D
Total organic carbon	-	-	-	-	-
Total petroleum hydrocarbons	-	-	-	-	-
Total phosphates	-	-	-	-	-
2,4,5-TP/silvex	-	-	-	-	-
1,1,1-Trichloroethane	-	-	-	-	D
1,1,2-Trichloroethane	4.0E-03	-	5.7E-02	5.7E-02	C
Trichloroethylene	-	-	-	-	-
Trichlorofluoromethane	3.0E-01	7.0E-01	-	-	-
1,2,3-Trimethlbenzene	-	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-	-
Trimethlbenzenes	-	-	-	-	-
1,7,7-Trimethylbicyclo[2,2,1]hept-2-ene	-	-	-	-	-
1,1,3-Trimethylcyclohexane	-	-	-	-	-
2,2,4-Trimethyl-1,3-pentanediol	-	-	-	-	-
1,3,5-Trinitrobenzene	5.0E-05	-	-	-	-
2,4,6-Trinitrotoluene	5.0E-04	-	3.0E-02	-	C
Vanadium	7.0E-03	-	-	-	-
Xylenes, total	2.0E+00	-	-	-	D
Zinc	3.0E-01	-	-	-	D

[a]From IRIS (USEPA 1994) and HEAST (USEPA 1993).
[b]RfD = Chronic Reference Dose.
[c]RfC = Chronic Reference Concentration.
[d]SF = Carcinogen Slope Factor.

3. REFERENCES

Blain, P. 1994. Massachusetts Department of Environmental Protection, Division of Water Supply. Personal communication, February 23, 1994 (617-292-5948).

EEI. Ecology and Environment, Inc. 1993. Master Environmental Plan, Fort Devens Sudbury Training Annex, Massachusetts (Draft Report). Contract No. DAAA15-90-D-0012. Ecology and Environment, Inc., Arlington, VA.

Hogan, P. 1992. Environmental Engineer, Technical Services Branch, NPDES Permit Program, Massachusetts Department of Environmental Protection, Worcester, MA. Personal communication, May 5, 1992 (508-792-7470).

USEPA. U.S. Environmental Protection Agency. 1988. CERCLA Compliance with Other Laws Manual, Draft Guidance, Vol. I. OSWER Directive 9234.1001. Office of Solid Waste and Emergency Response, Washington, DC.

USEPA. U.S. Environmental Protection Agency. 1989. Risk Assessment Guidance for Superfund, Volume I. Human Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

USEPA. U.S. Environmental Protection Agency. 1992. New interim Region IV guidance. Letter received February 11, 1992. Region IV, Atlanta, GA.

USEPA. U.S. Environmental Protection Agency. 1993a. Health Effects Assessment Summary Tables. Annual, FY-1993, Supplement No. 1 (July 1993), Supplement No. 2 (November 1993). OERR 9200.6-303-(93-1). Office of Emergency and Remedial Response, Washington, DC.

USEPA. U.S. Environmental Protection Agency. 1993b. Drinking Water Regulations and Health Advisories. Office of Drinking Water, Washington, DC. (Current as of December 1993).

USEPA. U.S. Environmental Protection Agency. 1994. Integrated Risk Information System (IRIS). Office of Health and Environmental Assessment. U.S. Environmental Protection Agency. EPA/600/8-86/032a.

APPENDIX J

SUDBURY BACKGROUND DATA

APPENDIX J

SUDBURY ANNEX BACKGROUND DATA

J.1 INTRODUCTION

Background concentration ranges for inorganic analytes in sediment, soil, and surface water were determined from designated background samples collected on or near the Sudbury Annex. The background sediment and soil databases were compared with regional data from the peer-reviewed scientific literature to assess their validity for use as background.

Appendix J is divided into three sections based on matrix. The sections are:

- Background Concentrations of Inorganic Analytes in Sediment;
- Background Concentrations of Inorganic Analytes in Soil;
- Background Concentrations of Inorganic Analytes in Surface Water.

Tables J-1 through J-4 contain on-site, local, and regional background analyte concentration ranges for sediment, soil, and surface water. Tables J-5 through J-9 provide a complete list of analytical results for background samples collected at the Annex and off-facility (Ministers Pond).

J.2 BACKGROUND CONCENTRATIONS OF INORGANIC ANALYTES IN SEDIMENT

E & E collected nine background sediment samples in September and November 1993. Three samples were taken from Taylor Brook (sites E3–BCK–D01, E3–BCK–D04, and E3–BCK–D08) and six from Ministers Pond (sites E3–OFF–D01 through E3–OFF–D06). Because several PAH compounds were measured in sediment from site E3–BCK–D01, the site was considered not to be representative of background conditions and was not used when determining background ranges. Because only two stream sediment samples remained, no method for the removal of outliers (statistical extremes) could be applied to the stream data. For inorganic analytes present in pond sediment above the certified reporting level (CRL), outliers were identified by the method of Dixon as described by Sokal and Rohlf (1981); none were found.

Example Calculation (Dixon's Test)

Dixon's test is carried out as follows as per lead. The variates are ordered from high to low so the first variate, Y_1, is the suspected outlier. Dixon's test statistic, r, is calculated as

$$r = (Y_2\text{-}Y_1)/(Y_{n\text{-}1}\text{-}Y_1)$$

This value is compared to the critical value of r, r_{crit}. For n = 8 at the 95 percent confidence level r_{crit} = 0.554 (Sokal and Rohlf 1981). If r is greater than r_{crit}, the variate is an outlier. In this example, 0.779 is greater than 0.554 so 39 is an outlier.

To determine if the second highest lead value is an outlier, Dixon's test can be applied a second time for the remaining seven variates. For seven variates r is calculated as

$$r = (Y_2\text{-}Y_1 1)/(Y_n\text{-}Y_1)$$

where Y_n is the last variate in the array. For this example,

$$r = (12.3\text{-}12.5)/(3.5\text{-}12.5) = 0.022$$

For n = 7 at the 95 percent confidence level r_{crit} = 0.507. Because r is less than r_{crit}, 12.5 is not an outlier (Sokal and Rohlf 1981).

Table J–1 lists concentration ranges for inorganic analytes for the designated background samples, excluding outliers. Separate ranges are presented for stream and pond sediment because these sediment types differ in grain-size distribution and organic-matter content, two factors that affect the ability of sediments to retain trace metals and major ions (Forsther and Wittman 1979). Fine-grained, organic-rich sediments, such as those from the center of a lake or pond, typically have higher levels of metals and major ions than coarse-grained organic-poor sediments, such as those from a high-energy stream. Inorganic analyte levels in site samples were compared with the maximum of the background range; exceedences were considered site-related contamination.

For comparison, Table J–1 also includes concentration ranges for inorganic analytes in surficial, mid-basin, sediment from remote New England lakes, and normal levels for Massachusetts lakes and ponds. For nearly all inorganic analytes, the maximum levels in stream and pond sediment from the Annex lie within or below the range for the New England and Massachusetts lakes. This suggests that comparing inorganic analyte levels in site samples to the maximum of the Annex background database was a sensitive method for identifying site-related contamination.

Table J–2 lists the names, locations, and inorganic analyte data for the New England lakes used to develop the concentration ranges reported in Table J–1. None of the lakes were affected by point sources of metal pollution. Atmospheric deposition was the only source of metals to the lakes and their watersheds. None of the lakes were located near major cities. "Normal" levels of eleven metals in sediment from Massachusetts lakes and ponds are from Rojko's (1990) proposed classification scheme.

J.3 BACKGROUND CONCENTRATIONS OF INORGANIC ANALYTES IN SOIL

Ten background soil samples for inorganic analytes were collected in September 1993. Outliers were identified by the method of Dixon as described by Sokal and Rohlf (1981). A single outlier for arsenic was found. Values listed as less than the CRL were converted to one-half the CRL for the calculations.

Table J–3 lists concentration ranges for inorganic analytes for the Annex background soil database, excluding outliers. Inorganic analyte levels in site samples were compared with the maximum of the background range; exceedences were considered to be a result of site-related contamination.

For comparison, Table J–3 also lists concentration ranges for inorganic analytes in uncontaminated soils of the eastern United States. For all analytes, the maximum concentration in the Annex background database lies within the range for the eastern United States, usually toward the low end of the range. This suggests that comparing inorganic analyte levels in site samples to the maximum of the Annex background database was a sensitive method for identifying site-related contamination.

L.4 BACKGROUND CONCENTRATIONS OF INORGANIC ANALYTES IN SURFACE WATER

E & E collected nine background surface-water samples for inorganic analytes in September and November 1993. Three samples were taken from Taylor Brook (sites E3–BCK–D01, E3–BCK–D04, and E3–BCK–D08) and six from Minister's Pond (sites E3–OFF–D01 through E3–OFF–D06). The samples were collected at the same time and locations as the background sediment samples. Because several PAH compounds were measured in sediment from site E3–BCK–D01, the site was considered not to be representative of background conditions and was not used when determining background concentration ranges for surface water. Because only two stream water samples remained, no formal test for outliers could be applied to the stream data. For analytes present in pond water above the CRL, Dixon's test (Sokal and Rohlf 1981) was used to identify outliers; none were found.

Table J–4 lists concentration ranges for inorganic analytes for the Annex background surface-water database. Separate ranges are presented for stream and pond water. Analyte levels in site samples were compared with the maximum of the background range; exceedences were considered to be a result of site-related contamination.

J.5 REFERENCES

Davis, A.O. and J.N. Galloway. 1981. Atmospheric lead and zinc deposition into lakes of the Eastern United States. pp. 401-408 In: S.J. Eisenreich (Ed.), Atmospheric Pollutants in Natural Waters, Ann Arbor Science Publishers, Ann Arbor, Michigan.

Forsther, U. and G.T.W. Wittman. 1979. Metal Pollution in the Aquatic Environments. Springer-Verlag, Berlin, Germany.

Galloway, J.N. and G.E. Likens. 1979. Atmospheric enhancement of metal deposition in Adirondack lake sediments. Limnology and Oceanography 24:427-433.

Heit, M., Y. Tan, C. Klusek and J.C. Burke. 1981. Anthropogenic trace elements and polycyclic aromatic hydrocarbon levels in sediment cores from two lakes in the Adirondack acid lake region. Water, Air, and Soil Pollution 15:441-464.

Kahl, J.S., S.A. Norton and J.S. Williams. 1984. Chronology, magnitude, and paleolimnological record of changing metal fluxes related to atmospheric deposition of acids and metals in New England. pp. 23-35 In: O.P. Bricker (Ed.) Geological Aspects of Acid Deposition, Butterworth Publishers, Boston, Massachusetts.

Norton, S.A., C.T. Hess and R.B. Davis. 1981. Rates of accumulation of heavy metals in pre- and post-European sediments in New England lakes. pp. 409-421 In: S.J. Eisenreich (Ed.) Atmospheric Pollutants in Natural Waters, Ann Arbor Science Publishers, Ann Arbor, Michigan.

Rojko, A. 1990. Heavy Metals in Sediments from Massachusetts Lakes and Ponds. Master's Report, Northeastern University, MA.

Shacklette, H.T. and J.G. Boerngen. 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States. U.S. Geological Survey Professional Paper 1270. U.S. Government Printing Office, Washington, D.C.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry, 2nd Edition. W.H. Freeman and Company, New York, NY.

Table J-1

CONCENTRATION RANGES FOR INORGANIC ANALYTES IN BACKGROUND SEDIMENTS FROM SUDBURY ANNEX AND OTHER NEW ENGLAND LOCATIONS

Analyte	Background STREAM Sediment from Sudbury[a] (mg/kg)	Background POND Sediment from Sudbury[b] (mg/kg)	Mid-Basin Bottom Sediment From Remote New England Lakes[c] (mg/kg)	"Normal" Levels in MA Lakes and Ponds[f] (mg/kg)
Aluminum	4,250 - 5,020	2,050 - 5,740	4,610 - 58,300	NR
Antimony	0.5[d]	0.5[d]	2.5 - 3.0	NR
Arsenic	1.22 - 2.03	2.10 - 9.56	5.3 - 13	<25
Barium	9.23 - 23.9	19.2 - 55.3	282	NR
Beryllium	0.093 - 0.180	0.5[d]	5.1 - 7.8	NR
Cadmium	0.5[d]	<0.5 - 2.06	1.5 - 3.0	<5
Calcium	357 - 562	1,640 - 4,550	1,250 - 28,400	NR
Chromium	6.95 - 9.66	5.2 - 12.8	7.6 - 30	<30
Cobalt	3.45 - 3.74	3.3 - 11.4	5.43	NR
Copper	3.79 - 6.33	4.47 - 10.9	8.7 - 20	<70
Iron	6,410 - 7,590	4,120 - 16,300	6,470 - 71,800	<30,000
Lead	4.1 - 4.48	11.5 - 49.4	53 - 310	<200
Magnesium	1,240 - 2,140	401 - 1,110	940 - 9,800	NR
Manganese	58.9 - 70.5	22.4 - 74.1	45 - 4,930	<350
Mercury			0.38 - 0.69	<0.35
Nickel	5.75 - 5.92	11.7 - 23.2	6.4 - 11	<35
Potassium	448 - 1520	<200 - 900	1,570 - 15,000	NR
Selenium	0.2[d]	0.2[d]	1.6 - 4.6	NR
Silver		<0.2 - 0.879	0.4 - 0.64	NR
Sodium	200[d]	200[d]	930 - 6,200	NR
Thallium	<0.5 - 0.195	0.5[d]	5.8 - 10	NR
Vanadium	9.23 - 17.0	5.61 - 21.8	40 - 142	<60
Zinc	20.8[e]	22.8 - 55.3	35 - 400	<250

Legend: NR = Not Reported.

[a]n = 2.
[b]Maximum of range determined after outlier removal (see text).
[c]See Table J-2.
[d]Certified reporting level (CRL).
[e]n = 1.
[f]Rojko (1990).

Source: Ecology and Environment, Inc. 1994.

Table J-2

METAL CONCENTATIONS (mg/kg) IN SURFICIAL, MID-BASIN, BOTTOM SEDIMENT FROM REMOTE NEW ENGLAND LAKES

Lake Name and Location	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
Mountain Lake Virginia (1)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	155-170
Woodhull Lake New York*** (2)	43,000	2.5-3.0	10.4	282	NR	3.0	28,400	25-30	5.43	18-20	27,600	160-200
Dream Lake @ NH (4)	15,900	NR	NR	NR	NR	NR	3,000	NR	NR	12-19	4,900	~55
Unnamed Pond @ Maine (4)	7,910	NR	NR	NR	NR	NR	1,250	NR	NR	NR	6,470	80-100
Sagamore Lake NY*** (3)	22,000	NR	5.3-6.5	NR	5.1-7.8	1.5-2.1	NR	8-11	NR	8.7-9.9	NR	53
Woods Lakes NY*** (3)	10,000-27,000	NR	13	NR	5.7-5.8	2.6-2.8	NR	7.6	NR	15	NR	138
Little Long Lake @ Maine (4)	30,000	NR	NR	NR	NR	NR	1,580	NR	NR	13-16	23,500	140
Granite Lake @ NH (5)	58,300	NR	NR	NR	NR	NR	2,940	NR	NR	NR	71,800	310
Klondike Pond @ Maine (5)	4,610	NR	NR	NR	NR	NR	3,020	NR	NR	NR	21,900	~72
Mountain Pond @ Maine (5)	30,300	NR	NR	NR	NR	NR	1,930	NR	NR	NR	21,800	125-150
Speck Pond @ Maine (5)	24,300	NR	NR	NR	NR	NR	2,200	NR	NR	NR	11,500	~123
Overall Range:	4,610-58,300	2.5-3.0	5.3-13	282	5.1-7.8	1.5-3.0	1,250-28,400	7.6-30	5.43	8.7-20	4,900-71,800	53-310

References at end of table.

Table J-2 (continued)

METAL CONCENTATIONS (mg/kg) IN SURFICIAL, MID-BASIN, BOTTOM SEDIMENT FROM REMOTE NEW ENGLAND LAKES

Lake Name and Location	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Mountain Lake Virginia (1)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	160-170
Woodhull Lake New York*** (2)	9,800	292	NR	10.2	15,000	NR	0.5-0.55	6,200	NR	40-55	150-400
Dream Lake @, NH (4)	1,100	100	NR	NR	2,800	NR	NR	1,780	NR	NR	72-96
Unnamed Pond @ Maine (4)	980	45	NR	NR	5,700	NR	NR	1,400	NR	NR	35-160
Sagamore Lake NY*** (3)	NR	NR	0.38-0.69	6.4-9.0	NR	1.6-1.9	0.4	NR	10	105-142	139-160
Woods Lakes NY*** (3)	NR	NR	0.46	11	NR	4.6	0.56-0.64	NR	5.8-6.9	114-126	345
Little Long Lake @ Maine (4)	2,100	98	NR	NR	1,570	NR	NR	930	NR	NR	100-160
Granite Lake @ NH (5)	6,200	1010	NR	NR	10,600	NR	NR	2,630	NR	NR	280
Klondike Pond @ Maine (5)	1,290	4930	NR	NR	12,800	NR	NR	4,870	NR	NR	215
Mountain Pond @ Maine (5)	1,780	3300	NR	NR	3,700	NR	NR	1,270	NR	NR	135-175
Speck Pond @ Maine (5)	940	890	NR	NR	1,700	NR	NR	1,520	NR	NR	62-164
Overall Range:	940-9,800	45-4,930	0.38-0.69	6.4-11	1,570-15,000	1.6-4.6	0.4-0.64	930-6,200	5.8-10	40-142	35-400

*NR = not reported.
**Lakes included in this table have no point source of metal polluton in their watersheds.
***Adirondack Mountain Region.
@ Values determined form figures presented by the cited author(s).

(1) Davis and Galloway 1981.
(2) Galloway and Likens 1979.
(3) Heit *et al.* 1981.
(4) Kahl *et al.* 1984.
(5) Norton *et al.* 1981.

Source: Ecology and Environment, Inc. 1994.

Table J-3

CONCENTRATION RANGES FOR INORGANIC ANALYTES IN BACKGROUND SOIL SAMPLES FROM THE ANNEX

Analyte	Range for Sudbury Background Soil Samples (mg/kg)[a]	Range for Soil in Eastern U.S. (mg/kg)[b]
Aluminum	1,980 - 10,400	7,000 - >100,000
Antimony	0.5[c]	<1 - 8.8
Arsenic	5.44 - 10	<0.1 - 73
Barium	6.66 - 25.1	10 - 1,500
Beryllium	0.13 - 0.446	<1 - 7
Cadmium	0.5[c]	NR
Calcium	98.9 - 1,170	100 - 280,000
Chromium	4.06 - 14.2	1 - 1,000
Cobalt	1.9 - 6.1	<0.3 - 70
Copper	4.0 - 10.7	<1 - 700
Iron	4600 - 12,300	100 - >100,000
Lead	8.0 - 150	<10 - 300
Magnesium	132 - 2,310	50 - 50,000
Manganese	9.0 - 95.8	<2 - 7,000
Mercury	<0.10 - 0.318	0.01 - 3.4
Nickel	3.5 - 10.7	<5 - 700
Potassium	295 - 617	50 - 37,000
Selenium	<0.2 - 0.571	<0.1 - 3.9
Silver		-
Sodium	200[c]	<500 - 50,000
Vanadium	14.5 - 33.0	<7 - 300
Thallium		
Zinc	12.3 - 44.6	<5 - 2,900

Legend: NR = not reported.

[a]Upper limit of range in background database determined after outlier removal (see text).
[b]Shacklette and Boerngen (1984).
[c]Certified reporting level (CRL).

Source: Ecology and Environment, Inc. 1994.

Table J-4

CONCENTRATION RANGES FOR ANALYTES IN BACKGROUND SURFACE-WATER SAMPLES FROM THE SUDBURY ANNEX, MASSACHUSETTS

Analyte	Range in Background STREAM Water (ug/L)[a]	Range in Background POND Water (ug/L)[b]
Aluminum	222 - 400	48.1 - 69.2
Antimony	5.0[c]	5.0[c]
Arsenic	1.96 - 3.15	2.0[c]
Barium	9.04 - 10.4	11.9 - 14.0
Beryllium	5.0[c]	5.0[c]
Cadmium	5.0[c]	5.0[c]
Calcium	7,690 - 8,520	7,910 - 8,730
Chromium	2.90 - 3.16	10.0
Cobalt	3.08 - 4.79	2.30 - 2.32[d]
Copper	10.0[c]	10.0[c]
Iron	2,770 - 4,810	954 - 1,110
Lead	3.82 - 10.3	0.89 - 3.02
Magnesium	1,760 - 1,890	2,080 - 2,250
Manganese	120 - 156	20.0 - 26.6
Mercury		
Nickel	10.0[c]	<10 - 11.3
Potassium	1,640 - 2,060	3,220 - 3,640
Selenium	2.0[c]	2.0[c]
Silver		
Sodium	5,760 - 14,000	16,500 - 18,000
Thallium		
Vanadium	4.08 - 4.72	10.0[c]
Zinc	11.5 - 13.3	53.6 - 67.8

[a]n = 2.
[maximum] of range determined after outlier removal (see text).
[c]Certified reporting level (CRL).
[d]n = 2.

Source: Ecology and Environment, Inc. 1994.

Table: J-5
Chemical Summary Report For Background Surficial Soils

Units: UGG

	Site ID	E3-BCK-S01	E3-BCK-S01	E3-BCK-S02	E3-BCK-S03	E3-BCK-S04	E3-BCK-S05
	Field Sample ID	SXBCK011	SXBCK011	SXBCK021	SXBCK031	SXBCK041	SXBCK051
	Sample Date	09/20/93	09/21/93	09/21/93	09/21/93	09/21/93	09/21/93
Test	Parameter						
TAL METAL	Aluminum		8010	9170	9640	10400	5090
	Arsenic		7.29 J	6.25 J	17.0 J!	8.90 J	5.91 J
	Barium		20.7	18.4	19.9	25.1	7.04
	Beryllium		0.247 J	0.288 J	0.350 J	0.405 J@	0.130 J
	Calcium		238 J	313 J	789	247 J	145 J
	Chromium		11.1	12.4	12.1	10.9	5.85
	Cobalt		4.04	4.67	3.96	4.29	2.07
	Copper		8.78	8.37	10.7	8.99	4.06
	Iron		11200	12300	9320	12000	6370
	Lead		39.0	53.0	110	29.0	16.0
	Magnesium		930	1220	1030	1110	490 J
	Manganese		35.4	47.0	71.1	73.3	25.8
	Mercury		< 0.100	0.165	0.106 J	< 0.100	< 0.100
	Nickel		6.59	7.39	8.25	7.33	4.00
	Potassium		587	617	481 K	347 K	218 BJ
	Selenium		0.571 J	0.476 J	0.350 J	0.422 J	0.249 J
	Vanadium		33.0	32.3	30.9	23.3	14.5
	Zinc		23.2	28.3	36.1	21.0	12.3
TCL Pest	Dieldrin	0.005 BC		0.005 C	0.008 U	0.003 U	0.004 C
	Endosulfan Sulfate	0.003 BU		0.008 U!	0.008 U!	0.008 C!	0.003 C
	Endosulfan,B	0.001 BJC		0.002 JU	0.004 U	0.005 U	0.002 JU
	Endrin	0.002 BJU		0.004 C	0.005 U	0.004 C	< 0.002
	Endrin Aldehyde	< 0.002		0.006 BC	< 0.002	0.011 KC	0.007 BC
	Heptachlor Epoxide	< 0.002		< 0.002	0.002 BJC	0.001 BJU	0.001 BJU
	Lindane	0.002 BJU		0.004 U	0.002 JU	0.002 U	0.001 JC
	P,P-DDD	0.013 C		0.006 KU	0.063 C	0.008 KU	< 0.002
	P,P-DDE	0.026 KC		0.008 CK	0.095 C	0.008 CK	0.001 BJC

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.

= Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Table: J-5
Chemical Summary Report For Background Surficial Soils

Units: UGG

	Site ID	E3-BCK-S01	E3-BCK-S01	E3-BCK-S02	E3-BCK-S03	E3-BCK-S04	E3-BCK-S05
	Field Sample ID	SXBCK011	SXBCK011	SXBCK021	SXBCK031	SXBCK041	SXBCK051
	Sample Date	09/20/93	09/21/93	09/21/93	09/21/93	09/21/93	09/21/93
Test	Parameter .						
TCL Pest	P,P-DDT	0.060 C		0.027 C	0.230 C	0.023 C	0.006 C
	alpha-BHC	< 0.002		0.004 C	0.003 C	0.004 U	0.003 U
	alpha-Chlordane	< 0.002		0.001 JU	0.001 JU	< 0.002	0.000 JU
	beta-BHC	< 0.002		< 0.002	< 0.002	0.004 U	< 0.002
	delta-BHC	< 0.002		< 0.002	0.001 BJU	0.003 KU	0.001 BJU
	gamma-Chlordane	< 0.002		0.001 JU	0.002 JC	0.002 JU	0.002 JU

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination. J= Estimated value. L= Result bias low. # = Exceeds ecological screening value
C= Confirmed on second column, U= Unconfirmed. K= Result bias high. R= Result rejected. @= Exceeds human health screening value. != Exceeds Background.

Date: 03/17/94
File Type: CSO
Site Type: AREA

Table: J-5
Chemical Summary Report For Background Surficial Soils

Units: UGG

	Site ID	E3-BCK-S06	E3-BCK-S07	E3-BCK-S08	E3-BCK-S09	E3-BCK-S10	
	Field Sample ID	SXBCK061	SXBCK071	SXBCK081	SXBCK091	SXBCK101	
	Sample Date	09/22/93	09/23/93	09/23/93	09/23/93	09/23/93	
Test	Parameter .						
TAL METAL	Aluminum	7810	1980	9870	3770	5640	
	Arsenic	5.44 J	7.46 J	10.0 J	9.17 J	9.95 J	
	Barium	18.3	23.2	15.8	6.66	10.2	
	Beryllium	0.271 J	0.214 JL	0.446 JL@	0.203 JL	0.287 JL	
	Calcium	462 J	1170	98.9 J	< 500	481 J	
	Chromium	14.2	4.06	11.1	6.25	9.92	
	Cobalt	6.13	1.91	4.44	2.66	3.10	
	Copper	8.93	10.5	7.65	8.04	5.33	
	Iron	12000	4600	8760	7740	7310	
	Lead	8.00	150	26.0	52.0	57.0	
	Magnesium	2310	132 J	962	194 J	796	
	Manganese	95.8	69.2	87.7	9.01	36.7	
	Mercury	< 0.100	0.318	0.100 J	< 0.100	0.118 J	
	Nickel	10.7	6.70	6.83	3.57	6.47	
	Potassium	581 K	262 BJ	291 B	219 BJ	295 K	
	Selenium	< 0.200 J	0.553 J	0.213 J	0.480 J	0.329 J	
	Vanadium	18.5	32.8	16.7	28.3	28.3	
	Zinc	20.0	44.6	27.7	28.8	20.4	
TCL Pest	Dieldrin	0.003 BU	0.023 C	0.002 BJU	< 0.002	0.008 KC	
	Endosulfan Sulfate	0.005 KU	0.003 BC	0.006 KU	0.001 BJU	0.003 BU	
	Endosulfan,B	0.002 U	0.004 C	0.002 JU	< 0.002	< 0.002	
	Endrin	0.002 BC	0.008 C	0.002 BJC	< 0.002	< 0.002	
	Endrin Aldehyde	0.009 C	< 0.002	< 0.002	0.001 JC	0.002 JU	
	Heptachlor Epoxide	0.001 BJU	0.006 KC!	< 0.002	< 0.002	0.001 JC	
	Lindane	0.003 BU	0.004 BU	0.003 BU	0.002 BJC	0.003 BJC	
	P,P-DDD	< 0.002	0.032 U	0.004 BU	0.005 U	0.011 C	
	P,P-DDE	0.002 BJC	0.139 C	0.004 BC	0.020 C	0.029 C	

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.

= Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Date: 03/17/94
File Type: CSO
Site Type: AREA

Table: J-5
Chemical Summary Report For Background Surficial Soils

Units: UGG

Test	Parameter	E3-BCK-S06	E3-BCK-S07	E3-BCK-S08	E3-BCK-S09	E3-BCK-S10	
	Field Sample ID	SXBCK061	SXBCK071	SXBCK081	SXBCK091	SXBCK101	
	Sample Date	09/22/93	09/23/93	09/23/93	09/23/93	09/23/93	
TCL Pest	P,P-DDT	0.005 U	0.139 C	0.007 U	0.051 C	0.069 C	
	alpha-BHC	0.003 BC	0.005 BC!	0.002 BJC	0.001 BJC	0.001 BJC	
	alpha-Chlordane	0.001 JU	0.004 C	0.001 JU	0.001 BJC	0.001 BJC	
	beta-BHC	0.002 JC	< 0.002	0.002 JC	< 0.002	< 0.002	
	delta-BHC	0.010 CK	0.001 BJC	< 0.002	< 0.002	< 0.002	
	gamma-Chlordane	0.002 BJU	0.005 KC	< 0.002	< 0.002	< 0.002	

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.

= Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Date: 03/17/94
File Type: CSE
Site Type: POND

Table: J-6
Chemical Summary Report For Sediments (Ministers Pond)
Background Pond
Units: UGG

	Site ID	E3-OFF-D01	E3-OFF-D02	E3-OFF-D03	E3-OFF-D04	E3-OFF-D05	E3-OFF-D06
	Field Sample ID	DXOFA011	DXOFA021	DXOFA031	DXOFA041	DXOFA051	DXOFA061
	Sample Date	11/09/93	11/09/93	11/09/93	11/09/93	11/09/93	11/09/93
Test	Parameter						
TAL METAL	Aluminum	5740 !	3850	4720	2320	2050	4330
	Arsenic	3.33 !	3.46 !	3.85 !	2.10 !	3.40 !	9.56 !#
	Barium	43.4 !	43.3 !	44.2 !	19.2	29.2 !	55.3 !
	Cadmium	0.669 BJ#	2.06 KJ#	0.863 BJ#	< 0.500	< 0.500	0.924 BJ#
	Calcium	3310 !	3550 !	3630 !	1640 !	2690 !	4550 !
	Chromium	12.8 !	9.81 !	10.6 !	5.20 J	5.33 J	11.3 J!
	Cobalt	4.50 !	5.82 !	6.11 !	3.30	3.65 J	11.4 !
	Copper	8.10 !	7.70 !	9.00 !	4.56	4.47	10.9 !
	Iron	6240	6810	6790	4120	5720	16300 !
	Lead	23.7 !	34.7 !#	37.5 !#	11.5 !	17.2 !	49.4 !#
	Magnesium	1480 J	948 J	1110 J	485 J	401 J	956 J
	Manganese	57.9	43.6	47.8	22.4	32.4	74.1 !
	Nickel	11.7 !	14.0 !	14.4 !	12.7 !	13.1 !	23.2 !#
	Potassium	545 KJ	< 200	900 J	491 KJ	198 BJ	< 200
	Silver	< 0.200	< 0.200	< 0.200	0.605 #	0.879 #	< 0.200
	Sodium	492 J	531 J	239 KJ	< 200	278 J	778 J
	Vanadium	12.6	10.8	12.6	5.61 J	8.52	21.8 !
	Zinc	32.5 !	44.3 !	41.8 !	22.8 !	23.9 !	55.3 !
TCL Pest	P,P-DDD	0.390 C#	0.063 C#	0.110 C#	0.022 JC#	0.004 JC#	0.060 JC#
	P,P-DDE	0.074 C#	< 0.010	0.037 JC#	< 0.010	< 0.002	< 0.010
TOC	Total Organic Carbon	336000	433000	439000	488000	437000	577000

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value.
K= Result bias high.
L= Result bias low.
R= Result rejected.
# = Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Date: 03/17/94
File Type: CSE
Site Type: POND

Table: J-6
Chemical Summary Report For Sediments (Ministers Pond)
Background Pond
Units: UGG

	Site ID	E3-OFF-D04	E3-OFF-D05	E3-OFF-D05	E3-OFF-D06	E3-OFF-D06
	Field Sample ID	DXOFA041	DX0FF051	DXOFA051	DX0FF061	DXOFA061
	Sample Date	11/09/93	11/09/93	11/09/93	11/09/93	11/09/93
Test	Parameter .					
TAL METAL	Aluminum	2320		2050		4330
	Arsenic	2.10 !		3.40 !		9.56 !#
	Barium	19.2		29.2 !		55.3 !
	Cadmium	< 0.500		< 0.500		0.924 BJ#
	Calcium	1640 !		2690 !		4550 !
	Chromium	5.20 J		5.33 J		11.3 J!
	Cobalt	3.30		3.65 J		11.4 !
	Copper	4.56		4.47		10.9 !
	Iron	4120		5720		16300 !
	Lead	11.5 !		17.2 !		49.4 !#
	Magnesium	485 J		401 J		956 J
	Manganese	22.4		32.4		74.1 !
	Nickel	12.7 !		13.1 !		23.2 !#
	Potassium	491 KJ		198 BJ		< 200
	Silver	0.605 #		0.879 #		< 0.200
	Sodium	< 200		278 J		778 J
	Vanadium	5.61 J		8.52		21.8 !
	Zinc	22.8 !		23.9 !		55.3 !
TCL Pest	P,P-DDD	0.022 JC#		0.004 JC#		0.060 JC#
	P,P-DDE	< 0.010		< 0.002		< 0.010
TOC	Total Organic Carbon	488000		437000		577000

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.
# = Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Date: 03/17/94
File Type: CSW
Site Type: POND

Table: J-7
Chemical Summary Report For Surface Waters (Ministers Pond)
Background Pond
Units: UGL

	Site ID	E3-OFF-D01	E3-OFF-D02	E3-OFF-D03	E3-OFF-D04	E3-OFF-D05	E3-OFF-D06
	Field Sample ID	WXOFA011	WXOFA021	WXOFA031	WXOFA041	WXOFA051	WXOFA061
	Sample Date	11/09/93	11/09/93	11/09/93	11/09/93	11/09/93	11/09/93
Test	Parameter .						
TAL METAL	Aluminum	61.1	58.3	69.2	53.9	61.0	48.1
	Antimony	< 5.00	< 5.00	1.25 J	< 5.00	< 5.00	< 5.00
	Barium	12.2 !	11.9 !	12.4 !	14.0 !	13.4 !	11.9 !
	Calcium	8510	8180	8280	8730 !	8580 !	7910
	Cobalt	< 10.0	2.32 J	< 10.0	2.30 J	< 10.0	< 10.0
	Iron	992	954	966	1030 #	1110 #	1020 #
	Lead	1.08 J	0.910 J	0.890 J	1.39 J	3.02 J	< 5.00
	Magnesium	2200 !	2120 !	2140 !	2250 !	2220 !	2080 !
	Manganese	26.6	25.1	26.2	26.3	26.5	20.0
	Nickel	11.3 !	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
	Potassium	3450 !	3220 !	3240 !	3420 !	3640 !	3200 K!
	Sodium	17500 !	16500 !	16800 !	18000 !	18000 !	17800 !
	Zinc	67.8 !	53.6 K!	60.9 K!	22.6 B!	30.4 K!	9.33 BJ

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.
# = Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Date: 03/17/94
File Type: CSW
Site Type: POND

Table: J-7
Chemical Summary Report For Surface Waters (Ministers Pond)
Background Pond
Units: UGG

	Site ID	E3-OFF-D04		E3-OFF-D04	E3-OFF-D05	E3-OFF-D06	
	Field Sample ID	WX0FA041		WXOFA041	WXOFA051	WXOFA061	
	Sample Date	11/09/93		11/09/93	11/09/93	11/09/93	
Test	Parameter .						
TAL METAL	Aluminum			53.9	61.0	48.1	
	Antimony			< 5.00	< 5.00	< 5.00	
	Barium			14.0 !	13.4 !	11.9 !	
	Calcium			8730 !	8580 !	7910	
	Cobalt			2.30 J	< 10.0	< 10.0	
	Iron			1030 #	1110 #	1020 #	
	Lead			1.39 J	3.02 J	< 5.00	
	Magnesium			2250 !	2220 !	2080 !	
	Manganese			26.3	26.5	20.0	
	Nickel			< 10.0	< 10.0	< 10.0	
	Potassium			3420 !	3640 !	3200 K!	
	Sodium			18000 !	18000 !	17800 !	
	Zinc			22.6 B!	30.4 K!	9.33 BJ	

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.
J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.
# = Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Table: J-8
Chemical Summary Report For Background Sediments

Units: UGG

Test	Parameter	E3-BCK-D01	E3-BCK-D04	E3-BCK-D08			
	Field Sample ID	DXBCK011	DXBCK041	DXBCK081			
	Sample Date	09/15/93	09/17/93	09/21/93			
TAL METAL	Aluminum	3290	4250	5020			
	Arsenic	2.93 !	2.03	1.22			
	Barium	12.8	9.23	23.9			
	Beryllium	0.153 JL	0.180 JL	0.093 J			
	Calcium	449 J	357 J	562 J			
	Chromium	9.21	6.95	9.66			
	Cobalt	3.76 !	3.45	3.74			
	Copper	5.89 L	6.33 L	3.79			
	Iron	6860	6410	7590			
	Lead	36.0 J!#	4.48 J	4.10 J			
	Magnesium	98700 !	124000 !	2140			
	Manganese	117 !	58.9	70.5			
	Nickel	7.98 !	5.92	5.75			
	Potassium	587	448 K	1520			
	Thallium	< 0.500	< 0.500	0.195 J			
	Vanadium	8.39	9.23	17.0			
	Zinc	31.4 J!	16.9 J	20.8			
TCL BNA	Anthracene	0.350 J#	< 0.330 R	< 0.660			
	Benzo(a)anthracene	1.50 @#	< 0.330 R	< 0.660			
	Benzo(a)pyrene	1.30 @#	< 0.330 R	< 0.660			
	Benzo(b)fluoranthene	2.00 @	< 0.330 R	< 0.660			
	Benzo(ghi)perylene	0.550	< 0.330 R	< 0.660			
	Benzo(k)fluoranthene	0.770 @	< 0.330 R	< 0.660			
	Chrysene	1.50 @#	< 0.330 R	< 0.660			
	Dibenzo(a,h)anthracene	0.170 J	< 0.330 R	< 0.660			
	Fluoranthene	3.80 #	< 0.330 R	< 0.660			
	Fluorene	0.130 J	< 0.330 R	< 0.660			

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.

= Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Date: 03/17/94
File Type: CSE
Site Type: POND

Table: J-8
Chemical Summary Report For Background Sediments

Units: UGG

	Site ID	E3-BCK-D01	E3-BCK-D04	E3-BCK-D08			
	Field Sample ID	DXBCK011	DXBCK041	DXBCK081			
	Sample Date	09/15/93	09/17/93	09/21/93			
Test	Parameter .						
TCL BNA	Indeno(1,2,3-cd)pyrene	0.690	< 0.330 R	< 0.660			
	PHEND5		0.410 R				
	Phenanthrene	2.20 #	< 0.330 R	< 0.660			
	Pyrene	2.70 #	< 0.330 R	< 0.660			
TCL Pest	Aldrin	0.001 BJU	0.007 C!#	< 0.002			
	Endosulfan Sulfate	0.002 BJU	0.001 BJU	0.001 JC			
	Endosulfan,A	0.000 JC	0.002 JU	0.004 BU!			
	Endrin	0.007 KC#	< 0.002 J	< 0.002 J			
	Heptachlor Epoxide	0.001 JC	0.001 JU	0.002 BJU!			
	Lindane	0.001 JU	< 0.002 J	0.001 JC			
	P,P-DDE	0.002 JC	0.004 BU#	0.002 BJC			
	delta-BHC	0.002 JC	< 0.002	< 0.002			
TOC	Total Organic Carbon	7870	7690	14200			
TPHC	Total Petroleum Hydrocarbons	32.9 !#	16.6 J#	< 20.0			

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.

= Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

Date: 03/17/94
File Type: CSW
Site Type: POND

Table: J-9
Chemical Summary Report For Background Surface Waters

Units: UGL

Test	Site ID	E3-BCK-D01	E3-BCK-D04	E3-BCK-D08		
	Field Sample ID	WXBCK011	WXBCK041	WXBCK081		
	Sample Date	09/15/93	09/17/93	09/21/93		
Test	Parameter .					
EXPLOSIVES	2-Nitrotoluene	< 1.00	< 1.00	< 1.00		
TAL METAL	Aluminum	63.4 J	400 J	222 J		
	Arsenic	< 2.00	3.15 @	1.96 J@		
	Barium	39.0 J!	10.4 J	9.04 J		
	Calcium	24100 !	8520	7690		
	Chromium	< 10.0 K	3.16 JK	2.90 JK		
	Cobalt	< 10.0	3.08 J	4.79 J		
	Iron	366 J	2770 J#	4810 J#		
	Lead	1.15 J	3.82 J#	10.3 #		
	Magnesium	2960 !	1760	1890		
	Manganese	315 !	156	120		
	Potassium	4140 !	2060	1640		
	Sodium	24300 !	14000	5760		
	Vanadium	< 10.0	4.72 J	4.08 J		
	Zinc	66.1 !	11.5 J	13.3 J		
TCL VOA	Tetrachloroethene	< 5.00	< 5.00	1.90 J@		
	Trichloroethene	< 5.00	< 5.00	1.80 J		
UN07	DIAZ	3.90	< 0.310	< 0.310		
WQP	Phosphorus, Total	< 10.0 J	280 J	110 J		

Source: USAEC IRDMIS Level 3/E & E, 1994 - Codes following values indicate data useability. (see below)

B= Attributable to field or laboratory contamination.
C= Confirmed on second column, U= Unconfirmed.

J= Estimated value. L= Result bias low.
K= Result bias high. R= Result rejected.

= Exceeds ecological screening value
@= Exceeds human health screening value.
!= Exceeds Background.

APPENDIX K

ECOLOGICAL INVESTIGATION FIELD FORMS

APPENDIX K

ECOLOGICAL INVESTIGATION FIELD FORMS

Appendix K compiles the information gathered during the July 1993 ecological survey conducted at sites P11, P13, P36, P37, and A12. These sites were originally designated as SI/RI sites and in the event that any of these sites proves to require an RI, ecological surveys were conducted on all of them. Copies of the following field forms have been included:

- Field maps indicating the locations of individual cover types;
- Cover type description forms;
- Basal area field forms; and
- United States Corps of Engineers Wetland forms.

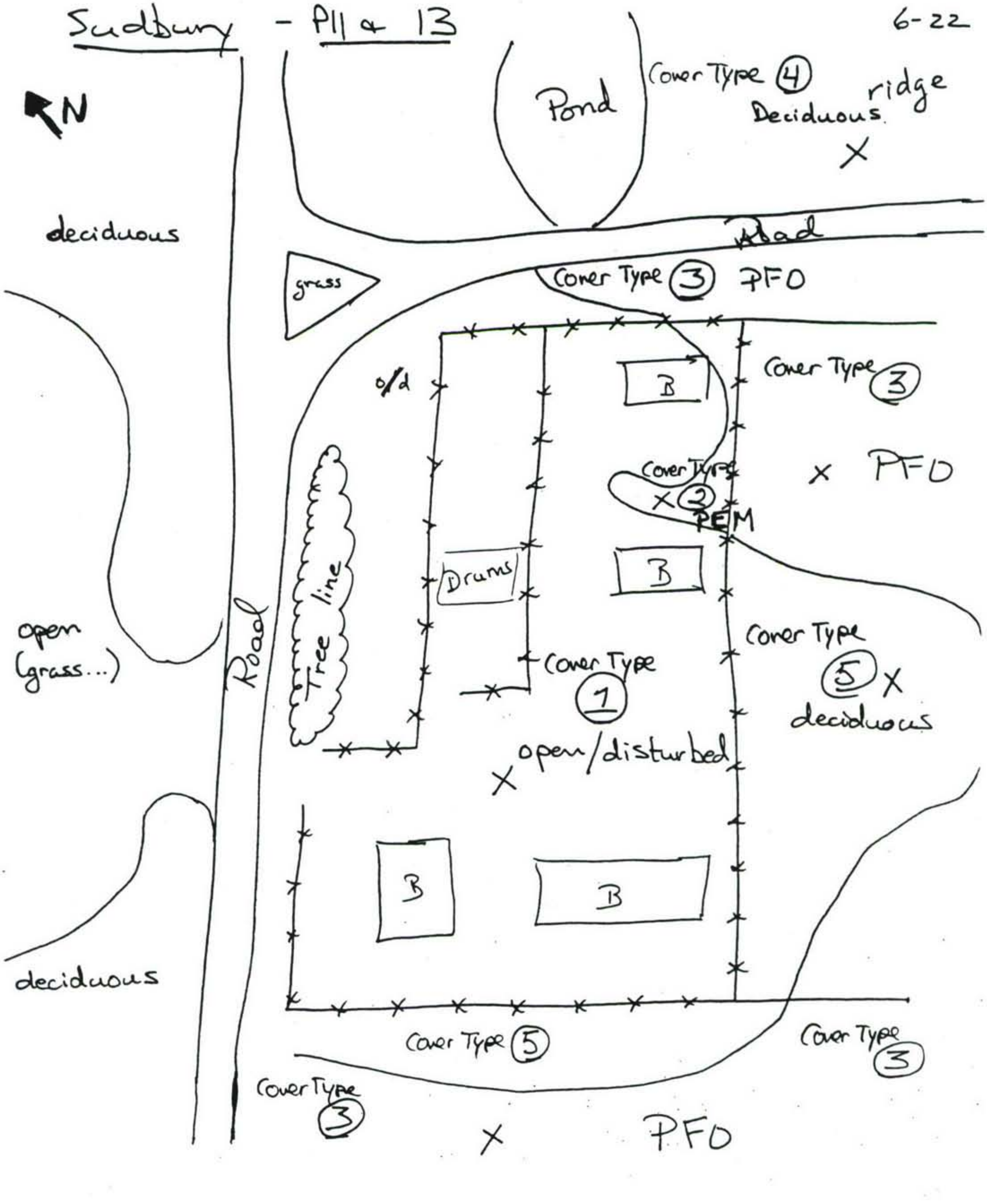
CONTENTS

(WATERSHED 1B)

- Field map
- For each cover type (5 total)
  - Cover type description form
  - Basal area field form
  - United States Corps of Engineers Wetland forms (except for cover type 5)

WATERSHED 1B TABLE
(List of Sites)

Site Number	Site Name
P11	Building T405 Area
P13	Massachusetts Fire Fighting Academy


Sudbury - P11 & 13
6-22
N
Pond
Cover Type 4
Deciduous
ridge
deciduous
Road
grass
Cover Type 3 PFO
o/d
Cover Type 3
Cover Type 2
PEM
PFO
B
Drums
Tree line
open (grass...)
Road
Cover Type 5
deciduous
Cover Type 1
open/disturbed
B
B
deciduous
Cover Type 5
Cover Type 3
Cover Type 3
PFO

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P11 + 13
Field Crew: Kim, Vangalio, Azzopardi

Date: 6-22
Photo #(s): 3-23, 24 + 25

Cover Type No.: 1
Cover Type Name: Open/disturbed

VEGETATION: (* = dominants)

Trees (~~DBH~~ veg. density= scattered (not in plot)
red maple black locust
red cedar

Saplings/shrubs (veg. density= scattered):
multiflora rose slippery elm white ash
rubus spp. red maple lowbush blueberry

Woody Vines (veg. density= along edges):
poison ivy

Herbs (veg. density= 80):
orchard grass* yarrow poverty grass goldenrods
Kentucky bluegrass* cinquefoil bedstraw

Comments (diversity, quality, exotics):
- shrubs occur around buildings
- areas of pavement (roads + sidewalks); numerous buildings

SOIL COMPOSITION: disturbed

SLOPE: 3-5%

HYDROLOGY: absent

WATER BODIES: two intermittent streams on the W and E sides; one small drainage in center (see cover type 2)

WILDLIFE:

Species Observed:

Other Evidence of Wildlife Use:

Wildlife Values:
- ___ travel corridors
- ___ abundance of cover
- ✓ abundance of food
- ✓ abundance of edge
- ___ cavity trees
- ___ standing dead snags
- ___ large, contiguous fore[st]

Available Wildlife Foods:
berries, seeds

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums
- roads, buildings, fences, drums, sidewalks ...

BASAL AREA FIELD FORM

Project: Sudbury Annex, P11 & 13
Cover type number: 1
Plot radius: ~30'

Date: 6-22
Crew: Azzopardi, Kim, Vangalio

DBH(in.)	Midpt.	BA/tree	SPECIES					
4-6	5	19.63						
6-8	7	38.47						
8-10	9	63.59						
10-12	11	94.99						
12-14	13	132.67						
14-16	15	176.63						
16-18	17	226.87						
18-20	19	283.39		No	Trees		(in plot)	
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species								
Total BA/plot								
Relative dominance (%)								

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

Project Title: Sudburry P11 P13

File Number:

Cover type 1 Transect: Plot:

Date: 6-22-93

DATA -- VEGETATION	Stratum and Species (DOMINANTS ONLY)	Dominance Ratio	Percent Dominance	NWI Status
Tree				
none				

Note: use asterisk * to indicate FAC-, FACU, or UPL species with observed adaptions to wetland hydrology

TALLY (Dominants ONLY)

OBL	FACW	FAC	*FAC-	*FACU	*UPL	FAC-	FACU	UPL
___	___	___	___	___	___	___	___	___

SUBTOTAL (HYDROPHYTES): ________ SUBTOTAL: ________

TOTAL: ________

$\frac{100 \times \text{SUBTOTAL (HYDROPHYTES)}}{\text{TOTAL}}$ = ________ = PERCENT HYDROPHYTES

DESCRIBE VEGETATION DISTURBANCE:

DESCRIBE ADAPTATIONS:

DATA -- SOIL

Soil Taxonomy: Typic Dystrochrept

Corps of Engineers Regional Drainage Class: somewhat excess. drained Criterion:

Is Published Soil Survey Available? Yes ☒ No ☐ Title/Date: Middlesex Conty 1991

Soil Type Mapped: Merrimac

Field Observations Confirm Type Mapped? Yes ☒ No ☐

Depth	Horizon	Matrix Color (Munsell, Moist)	Color of Mottles (Munsell, Moist) Abundance/Contrast	USDA Texture, Iron or manganese nodules or concretions, restrictive layers, root distribution, oxidized rhizospheres, etc.
0-1				roots
1-9		7.5 YR 3/3	none	silty sand
9-12		7.5 YR 5/8	none	sandy
12 - obstruction				

Remarks:

Sketch Landscape Position:

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

SOIL DETERMINATION

NOTE:
1. "NO" to all the following is evidence that the soil is NOT HYDRIC
2. This checklist is valid for use by the New England Corps of Engineers, and exclude the six New England States may be inappropriate
3. This interpretive routine may be inappropriate in unusual cases

Yes	No	
☐	☒	Soil is frequently PONDED or FLOODED for a duration longer than two weeks during the growing season. (attach an explanation of the basis for your conclusions).
☐	☒	The soil meets the Corps of Engineers regional criteria as a VERY POORLY DRAINED SOIL* and there is no evidence of altered hydrology
☐	☒	The soil meets the Corps of Engineers regional criteria as a POORLY DRAINED SOIL* and there is no evidence of altered hydrology
☐	☒	The soil meets the Corps of Engineers regional criteria as a SOMEWHAT POORLY DRAINED SOIL that has either of the following two characteristics*:

Yes NO
☐ ☐ 1. Within 8 inches of the soil surface there are:

Yes No
- ☐ ☐ a. soil mottles within an A or Ap horizon and the subsoil is mottled throughout; OR
- ☐ ☐ b. common to many, distinct or prominent mottles with a matrix of chroma 3 or less; OR
- ☐ ☐ c. distinct or prominent oxidized rhizospheres and the subsoil is mottled throughout.

☐ ☐ 2. Within 24 inches of the soil surface, there are mottles which are common to many, distinct or prominent, and that are chroma 2 or less, and one of the following:

Yes No
- ☐ ☐ a. In the horizon that lies within 10 inches of the soil surface and directly beneath a dark** A or Ap horizon, the matrix is chroma 3 or less; the mottles are at least 10% in abundance and distinct or prominent.
- ☐ ☐ b. When a dark** Ap horizon is between 10 and 14 inches thick, wetness morphology may be masked by organic matter. Normally, these problem situations will be considered hydric when: I. hydrophytes are prevalent, II. there is no evidence of altered hydrology, and III. in the horizon that lies directly beneath the Ap horizon, the matrix color is chroma 3 or less and mottles are at least 30% in abundance and distinct or prominent.

☐ Check here and attach a description of your procedures and conclusions if one of the following options were chosen for your hydric soil determination: measured redox potentials, colormetric test for ferrous iron test (α,α,-Dipyridil), or other measurements and observations.

* Typically in New England, soils having these morphologies will be classified in an aquic suborder or an aquic subgroup in soil taxonomy.
** Note: a dark A or Ap is defined as having a value of 3 or less and a chroma of 2 or less

Remarks:

DATA & DETERMINATION HYDROLOGY

NOTE:
1. Hydrology is often the most difficult feature to observe
2. Interpretations must consider the appropriateness of the observations in light of the season, recent weather conditions, and watershed alterations, etc
3. Interpretation of hydrology may require repeated observations over more than one season

☐ Recorded Data
- Stream, lake or tidal gage — Identification: ______
- Aerial Photograph — Identification: ______
- Other — Identification: ______

☐ No Recorded Data Available

REPORT ANY OF THE FOLLOWING OBSERVATIONS
- Depth to Free Water: >18"
- Depth to Saturation: >18"
- Describe Altered Hydrology: ______

- ☐ Inundated
- ☐ Saturated in upper 12 inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns within Wetlands

Remarks

CONCLUSIONS

Project Title:
Delineator:
Transect: Plot: Date:

	Yes	No
Greater than 50 Percent Hydrophytes?	☐	☐
Hydric Soils Criterion Met?	☐	☒
Wetland Hydrology Present?	☐	☒

IS THIS DATAPOINT WITHIN A WETLAND? Yes ☐ No ☐

Remarks

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P11 & 13
Field Crew: Vangalio, Azzopardi, Kim

Date: 6-22
Photo #(s): 4-1

Cover Type No.: 2
Cover Type Name: Wet meadow (PEM)

VEGETATION: (* = dominants)

Trees (DBH= veg. density= 0
none

Saplings/shrubs (veg. density= 10):
meadowsweet highbush blueberry
northern arrowwood

Woody Vines (veg. density= 0):
none

Herbs (veg. density= 98):
sensitive fern slender blue iris cutgrass
tearthumb cinnamon fern

Comments (diversity, quality, exotics):
- drainge has been culverted
- soil is moist and very thick

SOIL COMPOSITION: 7.5 YR 2/0

SLOPE: 0-3%

HYDROLOGY: present

WATER BODIES: intermittent stream/drainage

WILDLIFE:

Species Observed:

Other Evidence of Wildlife Use:

Wildlife Values:
- ____ travel corridors
- ____ abundance of cover
- _✓_ abundance of food
- _✓_ abundance of edge
- ____ cavity trees
- ____ standing dead snags
- ____ large, contiguous fore

Available Wildlife Foods:
berries, seeds

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums
- area has been cleared/cut in the past

BASAL AREA FIELD FORM

Project: Sudbury Annex, P11 & 13
Cover type number: 2
Plot radius: ~30'

Date: 6-22
Crew: Azzopardi, Vangalio, Kim

DBH(in.)	Midpt.	BA/tree			SPECIES			
4-6	5	19.63						
6-8	7	38.47						
8-10	9	63.59						
10-12	11	94.99						
12-14	13	132.67						
14-16	15	176.63						
16-18	17	226.87						
18-20	19	283.39		No	Trees			
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species								
Total BA/plot								
Relative dominance (%)								

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

Project Title: Sudburry P11 P13 File Number:

Cover type 2
~~Transect~~ Plot: Date: 6-22-93

DATA -- VEGETATION	Stratum and Species (DOMINANTS ONLY)	Dominance Ratio	Percent Dominance	NWI Status

Note: use asterisk * to indicate FAC-, FACU, or UPL species with observed adaptions to wetland hydrology

TALLY (Dominants ONLY)

OBL	FACW	FAC	*FAC-	*FACU	*UPL	FAC-	FACU	UPL

SUBTOTAL (HYDROPHYTES): ______ SUBTOTAL: ______

TOTAL: ______

100 x SUBTOTAL (HYDROPHYTES) / TOTAL = ______ = PERCENT HYDROPHYTES

DESCRIBE VEGETATION DISTURBANCE:

DESCRIBE ADAPTATIONS

DATA -- SOIL Soil Taxonomy: Histic Humaquept

Corps of Engineers Regional Drainage Class: very poorly drained Criterion: A3

Is Published Soil Survey Available? Yes ☒ No ☐ Title/Date: Middlesex County 1991

Soil Type Mapped: Scarboro Field Observations Confirm Type Mapped? Yes ☒ No ☐

Depth	Horizon	Matrix Color (Munsell, Moist)	Color of Mottles (Munsell, Moist) Abundance/Contrast	USDA Texture, Iron or manganese nodules or concretions, restrictive layers, root distribution, oxidized rhizospheres, etc.
0-3				decayed grass, roots
3-8		7.5YR3/2	none	
>8		N2/0		

Remarks:

Sketch Landscape Position:

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

SOIL DETERMINATION

NOTE:
1. "NO" to all the following is evidence that the soil IS NOT HYDRIC
2. This checklist is valid for use by the New England Corps of Engineers, use outside the six New England States may be inappropriate
3. This interpretive routine may be inappropriate in unusual cases

Yes	No	
☐	☒	Soil is frequently PONDED or FLOODED for a duration longer than two weeks during the growing season. (attach an explanation of the basis for your conclusions).
☒	☐	The soil meets the Corps of Engineers regional criteria as a VERY POORLY DRAINED SOIL* and there is no evidence of altered hydrology.
☐	☒	The soil meets the Corps of Engineers regional criteria as a POORLY DRAINED SOIL* and there is no evidence of altered hydrology.
☐	☒	The soil meets the Corps of Engineers regional criteria as a SOMEWHAT POORLY DRAINED SOIL that has either of the following two characteristics*:

Yes NO

☐ ☐ 1. Within 8 inches of the soil surface there are:

Yes No

- ☐ ☐ a. soil mottles within an A or Ap horizon and the subsoil is mottled throughout; OR
- ☐ ☐ b. common to many, distinct or prominent mottles with a matrix of chroma 3 or less; OR
- ☐ ☐ c. distinct or prominent oxidized rhizospheres and the subsoil is mottled throughout.

☐ ☐ 2. Within 24 inches of the soil surface, there are mottles which are common to many, distinct or prominent, and that are chroma 2 or less, and one of the following:

Yes No

- ☐ ☐ a. In the horizon that lies within 10 inches of the soil surface and directly beneath a dark** A or Ap horizon, the matrix is chroma 3 or less; the mottles are at least 10% in abundance and distinct or prominent.
- ☐ ☐ b. When a dark** Ap horizon is between 10 and 14 inches thick, wetness morphology may be masked by organic matter. Normally, these problem situations will be considered hydric when: I. hydrophytes are prevalent, II. there is no evidence of altered hydrology, and III. in the horizon that lies directly beneath the Ap horizon, the matrix color is chroma 3 or less and mottles are at least 10% in abundance and distinct or prominent.

☐ Check here and attach a description of your procedures and conclusions if one of the following options were chosen for your hydric soil determination: measured redox potentials, colormetric test for ferrous iron test (α,α,-Dipyridil), or other measurements and observations.

* Typically in New England, soils having these morphologies will be classified in an aquic suborder or an aquic subgroup in soil taxonomy.
** Note: a dark A or Ap is defined as having a value of 3 or less and a chroma of 2 or less

Remarks:

DATA & DETERMINATION HYDROLOGY

NOTE:
1. Hydrology is often the most difficult feature to observe
2. Interpretations must consider the appropriateness of the observations in light of the season, recent weather conditions, and watershed alterations, etc
3. Interpretation of hydrology may require repeated observations over more than one season

☐ Recorded Data:

- Stream, lake or tidal gage — Identification: ____
- Aerial Photograph — Identification: ____
- Other — Identification: ____

☐ No Recorded Data Available

REPORT ANY OF THE FOLLOWING OBSERVATIONS:

- Depth to Free Water: 12"
- Depth to Saturation: 8"
- Describe Altered Hydrology: ____

☐ Inundated
☒ Saturated in upper 12 inches
☐ Water Marks
☐ Drift Lines
☐ Sediment Deposits
☒ Drainage Patterns within Wetlands

Remarks:

CONCLUSIONS

Project Title:
Delineator:
Transect: Plot: Date:

	Yes	No
Greater than 50 Percent Hydrophytes?	☐	☐
Hydric Soils Criterion Met?	☒	☐
Wetland Hydrology Present?	☒	☐

IS THIS DATAPOINT WITHIN A WETLAND? Yes ☐ No ☐

Remarks:

recycled paper ecology and environment

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P11 + 13
Field Crew: Kim, Azzopardi, Vangalio

Date: 6-22
Photo #(s): 4-2

Cover Type No.: 3
Cover Type Name: Red maple - cinnamon fern forested wetland (PFO)

VEGETATION: (* = dominants)

Trees (~~DBH~~ veg. density= 85
red maple * slippery elm

Saplings/shrubs (veg. density= 20):
white pine red maple

Woody Vines (veg. density= 0):
none

Herbs (veg. density= 30):
skunk cabbage cinnamon fern royal fern jewelweed
sphagnum moss grasses highbush blueberry

Comments (diversity, quality, exotics):
- very immature stand
- herb. density is 80% in the eastern end (more fern + cabbage)

SOIL COMPOSITION: 7.5 YR 2/0 muck

SLOPE:

HYDROLOGY: present

WATER BODIES: intermittent strea[m] and dredged channels

WILDLIFE:

Species Observed:
deer (scat)
raccoon (tracks)

Other Evidence of Wildlife Use:

Wildlife Values:
- ___ travel corridors
- ✓ abundance of cover
- ___ abundance of food
- ✓ abundance of edge
- ___ cavity trees
- ✓ standing dead snags
- ___ large, contiguous fore[st]

Available Wildlife Foods:
berries, seeds

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums
- 2 dredged channels behind the PEM (cover type 2)
- old roads through area

BASAL AREA FIELD FORM

Project: Sudbury Annex, P11 & 13
Cover type number: 3
Plot radius: ~30'

Date: 6-22
Crew: Vangalio, Kim, Azzopardi

DBH(in.)	Midpt.	BA/tree	red maple	slippery elm	SPECIES			
4-6	5	19.63	卌 卌 卌 |||	||				
6-8	7	38.47	卌 ||||					
8-10	9	63.59	卌					
10-12	11	94.99						
12-14	13	132.67						
14-16	15	176.63						
16-18	17	226.87						
18-20	19	283.39						
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species			1017.52	39.26				
Total BA/plot			1056.78 →					
Relative dominance (%)			96	4				

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

Project Title: Sudburry P11 P13 File Number:

Cover type: 3 ~~Transect~~: Plot: Date: 6-22-93

DATA -- VEGETATION	Stratum and Species (DOMINANTS ONLY)	Dominance Ratio	Percent Dominance	NWI Status
Tree				
	Acer rubrum	1017.52/1056.78	96	FAC

Note: use asterisk * to indicate FAC-, FACU, or UPL species with observed adaptions to wetland hydrology

TALLY (Dominants ONLY)

OBL	FACW	FAC	*FAC-	*FACU	*UPL	FAC-	FACU	UPL

SUBTOTAL (HYDROPHYTES): ______ SUBTOTAL: 1

TOTAL ______

100 x SUBTOTAL (HYDROPHYTES) / TOTAL = ______ = PERCENT HYDROPHYTES

DESCRIBE VEGETATION DISTURBANCE:

DESCRIBE ADAPTATIONS:

DATA -- SOIL Soil Taxonomy: Histic Humaquept

Corps of Engineers Regional Drainage Class: very poorly drained Criterion: A3

Is Published Soil Survey Available? Yes ☒ No ☐ Title/Date: Middlesex County 1991

Soil Type Mapped: Scarboro Field Observations Confirm Type Mapped? Yes ☒ No ☐

Depth	Horizon	Matrix Color (Munsell, Moist)	Color of Mottles (Munsell, Moist) Abundance/Contrast	USDA Texture, Iron or manganese nodules or concretions, restrictive layers, root distribution, oxidized rhizospheres, etc.
0-2				roots
2-10		7.5YR 2/0	none	muck
>10		7.5YR 2/0	none	muck

Remarks:

Sketch Landscape Position:

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

SOIL DETERMINATION

NOTE:
1. "NO" to all the following is evidence that the soil is NOT HYDRIC
2. This checklist is valid for use by the New England Corps of Engineers, use outside the six New England States may be inappropriate
3. This interpretive routine may be inappropriate in unusual cases

Yes	No	
☐	☒	Soil is frequently PONDED or FLOODED for a duration longer than two weeks during the growing season (attach an explanation of the basis for your conclusions)
☒	☐	The soil meets the Corps of Engineers regional criteria as a VERY POORLY DRAINED SOIL* and there is no evidence of altered hydrology
☐	☒	The soil meets the Corps of Engineers regional criteria as a POORLY DRAINED SOIL* and there is no evidence of altered hydrology
☐	☒	The soil meets the Corps of Engineers regional criteria as a SOMEWHAT POORLY DRAINED SOIL that has either of the following two characteristics*:

Yes	NO	
☐	☐	1. Within 8 inches of the soil surface there are:
☐	☐	a. soil mottles within an A or Ap horizon and the subsoil is mottled throughout; OR
☐	☐	b. common to many, distinct or prominent mottles with a matrix of chroma 3 or less; OR
☐	☐	c. distinct or prominent oxidized rhizospheres and the subsoil is mottled throughout
☐	☐	2. Within 24 inches of the soil surface, there are mottles which are common to many, distinct or prominent, and that are chroma 2 or less, and one of the following:
☐	☐	a. In the horizon that lies within 10 inches of the soil surface and directly beneath a dark** A or Ap horizon, the matrix is chroma 3 or less; the mottles are at least 10% in abundance and distinct or prominent
☐	☐	b. When a dark** Ap horizon is between 10 and 14 inches thick, wetness morphology may be masked by organic matter. Normally, these problem situations will be considered hydric when: i. hydrophytes are prevalent, ii. there is no evidence of altered hydrology, and iii. in the horizon that lies directly beneath the Ap horizon, the matrix color is chroma 3 or less and mottles are at least 10% in abundance and distinct or prominent.

☐ Check here and attach a description of your procedures and conclusions if one of the following options were chosen for your hydric soil determination: measured redox potentials, colormetric test for ferrous iron test (α,α,-Dipyridil), or other measurements and observations.

* Typically in New England, soils having these morphologies will be classified in an aquic suborder or an aquic subgroup in soil taxonomy
** Note: a dark A or Ap is defined as having a value of 3 or less and a chroma of 2 or less

Remarks:

DATA & DETERMINATION HYDROLOGY

NOTE
1. Hydrology is often the most difficult feature to observe
2. Interpretations must consider the appropriateness of the observations in light of the season, recent weather conditions, and watershed alterations, etc
3. Interpretation of hydrology may require repeated observations over more than one season

☐ Recorded Data

Stream, lake or tidal gage — Identification ______

Aerial Photograph — Identification ______

Other — Identification ______

☐ No Recorded Data Available

REPORT ANY OF THE FOLLOWING OBSERVATIONS

Depth to Free Water: 10"

Depth to Saturation: 3"

Describe Altered Hydrology ______

☐ Inundated

☒ Saturated in upper 12 inches

☒ Water Marks

☐ Drift Lines

☐ Sediment Deposits

☐ Drainage Patterns within Wetlands

Remarks: water stained leaves
adventitious roots
shallow root systems

CONCLUSIONS

Project Title:

Delineator:

Transect: Plot: Date:

	Yes	No
Greater than 50 Percent Hydrophytes?	☐	☐
Hydric Soils Criterion Met?	☒	☐
Wetland Hydrology Present?	☒	☐
IS THIS DATAPOINT WITHIN A WETLAND?	☐	☐

Remarks

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P11 & 13
Field Crew: Vangalio, Kim, Azzopardi

Date: 6-22
Photo #(s): 4-3

Cover Type No.: 4
Cover Type Name: Aspen forest

VEGETATION: (* = dominants)

Trees (DBH= veg. density= 60
quaking aspen*, red oak, white pine, shagbark hickory

Saplings/shrubs (veg. density= 60):
white pine, s. hickory, red oak
red maple, flowering dogwood

Woody Vines (veg. density= 30):
poison ivy, Virginia creeper, rubus spp.

Herbs (veg. density= 10):
asters, goldenrods
grasses

Comments (diversity, quality, exotics):

SOIL COMPOSITION: 7.5 YR 3/2

SLOPE: 13-15%

HYDROLOGY: absent

WATER BODIES: adjacent to intermittent stream

WILDLIFE:

Species Observed:

Other Evidence of Wildlife Use:

Wildlife Values:

- ___ travel corridors
- ✓ abundance of cover
- ✓ abundance of food
- ✓ abundance of edge
- ___ cavity trees
- ___ standing dead snags
- ___ large, contiguous fore

Available Wildlife Foods:
acorns, nuts, catkins & seeds, berries

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums

- adjacent to road

BASAL AREA FIELD FORM

Project: Sudbury Annex, P11 + 13
Cover type number: 4
Plot radius: ~30'

Date: 6-22
Crew: Vangalio, Azzupardi, Kim

DBH(in.)	Midpt.	BA/tree	SPECIES: quaking aspen	red oak	white pine	shagbark hickory		
4-6	5	19.63	𝍸 II	I		I		
6-8	7	38.47	I					
8-10	9	63.59	I	I	I			
10-12	11	94.99	I		I			
12-14	13	132.67						
14-16	15	176.63						
16-18	17	226.87						
18-20	19	283.39						
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species			334.46	83.22	158.58	19.63		
Total BA/plot			595.89 →					
Relative dominance (%)			56	14	27	3		

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

Project Title: Sudburry P11 P13 File Number

~~Transects~~ Cover type 4 Plot: Date: 6-22-93

DATA -- VEGETATION Stratum and Species (DOMINANTS ONLY)	Dominance Ratio	Percent Dominance	NWI Status
Tree			
Populus tremuloides	334.46/595.89	56	FACU

Note: use asterisk * to indicate FAC-, FACU, or UPL species with observed adaptions to wetland hydrology

TALLY (Dominants ONLY)

OBL	FACW	FAC	*FAC-	*FACU	*UPL	FAC-	FACU	UPL
___	___	___	___	___	___	___	___	___

SUBTOTAL (HYDROPHYTES): ______ SUBTOTAL: ______

TOTAL ______

$\frac{100 \times \text{SUBTOTAL (HYDROPHYTES)}}{\text{TOTAL}}$ = ______ = PERCENT HYDROPHYTES

DESCRIBE VEGETATION DISTURBANCE:

DESCRIBE ADAPTATIONS:

DATA -- SOIL Soil Taxonomy:

Corps of Engineers Regional Drainage Class:

Criterion:

Is Published Soil Survey Available? Yes ☒ No ☐ Title/Date: Middlesex County 1991

Soil Type Mapped: Carver

Field Observations Confirm Type Mapped? Yes ☐ No ☐

Depth	Horizon	Matrix Color (Munsell, Moist)	Color of Mottles (Munsell, Moist) Abundance/Contrast	USDA Texture, Iron or manganese nodules or concretions, restrictive layers, root distribution, oxidized rhizospheres, etc.
0-1				
1-10		7.5YR 3/3	none	sandy loam
10-18		7.5YR 3/2	none	sandy loam

Remarks:

Sketch Landscape Position

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

SOIL DETERMINATION

NOTE:
1. "NO" to all the following is evidence that the soil IS NOT HYDRIC
2. This checklist is valid for use by the New England Corps of Engineers, use outside the six New England States may be inappropriate
3. This interpretive routine may be inappropriate in unusual cases

Yes No

☐ ☐ Soil is frequently PONDED or FLOODED for a duration longer than two weeks during the growing season (attach an explanation of the basis for your conclusions)

☐ ☐ The soil meets the Corps of Engineers regional criteria as a VERY POORLY DRAINED SOIL* and there is no evidence of altered hydrology

☐ ☐ The soil meets the Corps of Engineers regional criteria as a POORLY DRAINED SOIL* and there is no evidence of altered hydrology

☐ ☐ The soil meets the Corps of Engineers regional criteria as a SOMEWHAT POORLY DRAINED SOIL that has either of the following two characteristics*:

Yes NO

☐ ☐ 1. Within 8 inches of the soil surface there are

Yes No

☐ ☐ a. soil mottles within an A or Ap horizon and the subsoil is mottled throughout; OR

☐ ☐ b. common to many, distinct or prominent mottles with a matrix of chrome 3 or less, OR

☐ ☐ c. distinct or prominent oxidized rhizospheres and the subsoil is mottled throughout

☐ ☐ 2. Within 24 inches of the soil surface, there are mottles which are common to many, distinct or prominent, and that are chrome 2 or less, and one of the following:

Yes No

☐ ☐ a. In the horizon that lies within 10 inches of the soil surface and directly beneath a dark** A or Ap horizon, the matrix is chrome 3 or less; the mottles are at least 10% in abundance and distinct or prominent

☐ ☐ b. When a dark** Ap horizon is between 10 and 14 inches thick, wetness morphology may be masked by organic matter. Normally, these problem situations will be considered hydric when: i. hydrophytes are prevalent, ii. there is no evidence of altered hydrology, and iii. in the horizon that lies directly beneath the Ap horizon, the matrix color is chrome 3 or less and mottles are at least 10% in abundance and distinct or prominent.

☐ Check here and attach a description of your procedures and conclusions if one of the following options were chosen for your hydric soil determination: measured redox potentials, colormetric test for ferrous iron test (α,α,-Dipyridil), or other measurements and observations.

* Typically in New England, soils having these morphologies will be classified in an aquic suborder or an aquic subgroup in soil taxonomy.
** Note: a dark A or Ap is defined as having a value of 3 or less and a chroma of 2 or less

Remarks:

DATA & DETERMINATION HYDROLOGY

NOTE
1. Hydrology is often the most difficult feature to observe
2. Interpretations must consider the appropriateness of the observations in light of the season, recent weather conditions, and watershed alterations, etc
3. Interpretation of hydrology may require repeated observations over more than one season

☐ Recorded Data

Stream, lake or tidal gage — Identification ______

Aerial Photograph — Identification ______

Other — Identification ______

☐ No Recorded Data Available

REPORT ANY OF THE FOLLOWING OBSERVATIONS

Depth to Free Water: >18"

Depth to Saturation: >18"

Describe Altered Hydrology ______

☐ Inundated

☐ Saturated in upper 12 inches

☐ Water Marks

☐ Drift Lines

☐ Sediment Deposits

☐ Drainage Patterns within Wetlands

Remarks

CONCLUSIONS

Project Title

Delineator

Transect — Plot: — Date:

	Yes	No
Greater than 50 Percent Hydrophytes?	☐	☐
Hydric Soils Criterion Met?	☐	☒
Wetland Hydrology Present?	☐	☒

IS THIS DATAPOINT WITHIN A WETLAND? Yes ☐ No ☐

Remarks

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P11 + 13
Field Crew: Azzopardi, Kim, Vangalio

Date: 6-23
Photo #(s): 4-5

Cover Type No.: 5
Cover Type Name: Red maple forest

VEGETATION: (* = dominants)

Trees (DBH= veg. density= 85
red maple* white pine red cedar slippery elm
red oak black cherry white ash

Saplings/shrubs (veg. density= 10):
red maple silky dogwood
red oak

Woody Vines (veg. density= 90):
poison ivy*

Herbs (veg. density= 2):
grasses, goldenrods

Comments (diversity, quality, exotics):
• very dense and immature

SOIL COMPOSITION: 7.5 YR 3/2

SLOPE: 0-3 %

HYDROLOGY: absent

WATER BODIES: adjacent to PFO drainages

WILDLIFE:

Species Observed:
turkey (heard)

Other Evidence of Wildlife Use:

Wildlife Values:

- ____ travel corridors
- ✓ abundance of cover
- ____ abundance of food
- ✓ abundance of edge
- ____ cavity trees
- ____ standing dead snags
- ____ large, contiguous fore:

Available Wildlife Foods:
seeds, pine cones

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums

• near fence and roads

BASAL AREA FIELD FORM

Project: Sudbury Annex, P11 & 13
Cover type number: 5
Plot radius: ~30'

Date: 6-23
Crew: Azzopardi, Kim, Vangalio

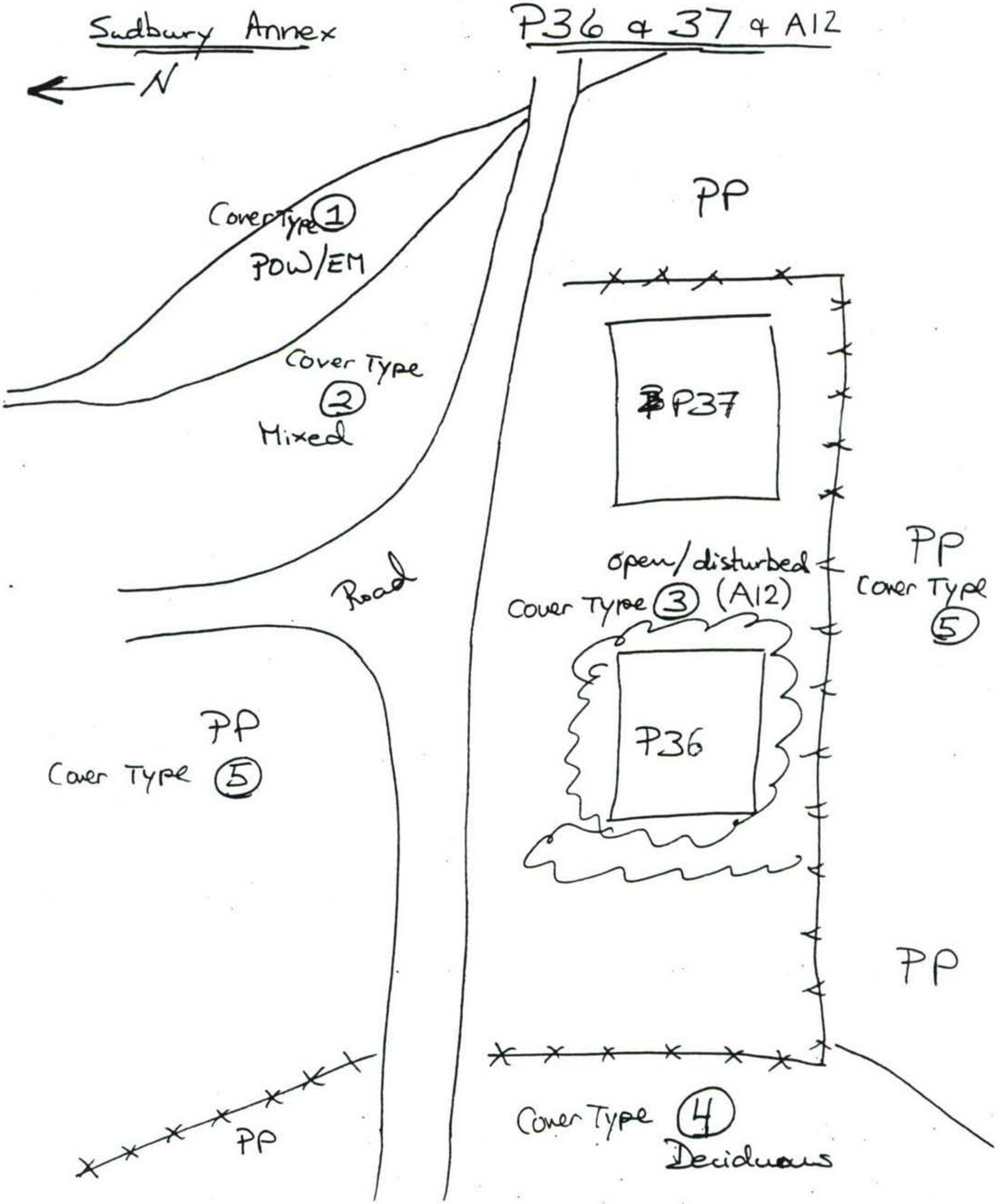
DBH(in.)	Midpt.	BA/tree	red maple	red oak	SPECIES white ash	red cedar	black cherry	slippery elm	whit[e] pin[e]
4-6	5	19.63	~~IIII~~ I		I		I		
6-8	7	38.47	III			I		I	
8-10	9	63.59	II		I				
10-12	11	94.99	I						
12-14	13	132.67					I		
14-16	15	176.63		I					I
16-18	17	226.87							
18-20	19	283.39							
20-22	21	346.19							
22-24	23	415.27							
24-26	25	490.63							
26-28	27	572.27							
28-30	29	660.19							
30-32	31	754.39							
32-34	33	854.87							
34-36	35	961.63							
Total BA/species			455.36	176.63	83.22	38.47	152.30	38.47	176.[6]
Total BA/plot			1121.08 →						
Relative dominance (%)			41	16	8	3	13	3	16

CONTENTS

(WATERSHED 2)

- Field map;
- For each cover type (5 total)
  - Cover type description form
  - Basal area field form
  - United States Corps of Engineers Wetland forms (only for cover types 1 and 2).

WATERSHED 2 TABLE (List of Sites)	
Site Number	**Site Name**
A12	PCB Spill; Remediation Area
P36	Former Raytheon Building T104
P37	Building T106 UST


Sudbury Annex
P36 & 37 & A12
N
Cover Type 1
POW/EM
Cover Type 2
Mixed
Road
PP
P37
open/disturbed
Cover Type 3 (A12)
PP
Cover Type 5
P36
PP
Cover Type 5
PP
PP
Cover Type 4
Deciduous

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P36 + 37
Field Crew: Vangalio, Kim, Azzopardi

Date: 6-21
Photo #(s):
3-15

Cover Type No.: 1
Cover Type Name: Open water wetland (POW)

VEGETATION: (* = dominants)

Trees (DBH= veg. density= 1%
hemlock (scattered)

Saplings/shrubs (veg. density= 5%):
speckled alder, red maple

Woody Vines (veg. density= 0):
none

Herbs (veg. density= 50):
jewelweed water lily (yellow) sensitive fern sedges slender-leaved iri
boneset cattails skunk cabbage rushes

Comments (diversity, quality, exotics):
- vegetation is Concentrated around the edges
- dead snags in water
- cattails are concentrated in northern end

SOIL COMPOSITION: muck

SLOPE: 0

HYDROLOGY: open water

WATER BODIES: 60% open water: pond formed at widening of Marlboro Brook

WILDLIFE:

Species Observed:
painted turtle

Other Evidence of Wildlife Use:

Wildlife Values:
- ____ travel corridors
- ____ abundance of cover
- ____ abundance of food
- ____ abundance of edge
- ____ cavity trees
- ✓ standing dead snags
- ____ large, contiguous fore

Available Wildlife Foods:

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums
- South end of pond has been culverted

BASAL AREA FIELD FORM

Project: Sudbury Annex, P36 & 37
Cover type number: 1
Plot radius: ~30'

Date: 6-21
Crew: Kim, Vangalio, Azzopardi

DBH(in.)	Midpt.	BA/tree			SPECIES			
4-6	5	19.63						
6-8	7	38.47						
8-10	9	63.59						
10-12	11	94.99						
12-14	13	132.67						
14-16	15	176.63						
16-18	17	226.87						
18-20	19	283.39		No	Trees (not	in	plot)	
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species								
Total BA/plot								
Relative dominance (%)								

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

Project Title: Sudburry P36 P37 File Number:

~~Transect~~ Cover type 1 Plot: Date: 6-21-93

DATA -- VEGETATION	Stratum and Species (DOMINANTS ONLY)	Dominance Ratio	Percent Dominance	NWI Status
Tree				
none				

Note: use asterisk * to indicate FAC-, FACU, or UPL species with observed adaptions to wetland hydrology

TALLY (Dominants ONLY)

OBL	FACW	FAC	*FAC-	*FACU	*UPL	FAC-	FACU	UPL
___	___	___	___	___	___	___	___	___

SUBTOTAL (HYDROPHYTES): ________ SUBTOTAL: 1

TOTAL ________

100 × SUBTOTAL (HYDROPHYTES) / TOTAL = ________ = PERCENT HYDROPHYTES

DESCRIBE VEGETATION DISTURBANCE:

DESCRIBE ADAPTATIONS:

DATA -- SOIL Soil Taxonomy: Typic Medisaprist

Corps of Engineers Regional Drainage Class: very poorly drained Criterion: A3

Is Published Soil Survey Available? Yes ☒ No ☐ Title/Date: Middlesex County 1991

Soil Type Mapped: Montauk * Field Observations Confirm Type Mapped? Yes ☐ No ☒

Depth	Horizon	Matrix Color (Munsell, Moist)	Color of Mottles (Munsell, Moist) Abundance/Contrast	USDA Texture, iron or manganese nodules or concretions, restrictive layers, root distribution, oxidized rhizospheres, etc.
<18"		7.5YR 2/0		muck

Remarks: *resembles Freetown muck which occurs at nearby stream

Sketch Landscape Position:

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

SOIL DETERMINATION

NOTE:
1. "NO" to all the following is evidence that the soil is NOT HYDRIC
2. This checklist is valid for use by the New England Corps of Engineers, use outside the six New England States may be inappropriate
3. This interpretive routine may be inappropriate in unusual cases

Yes	No	
☐	☒	Soil is frequently PONDED or FLOODED for a duration longer than two weeks during the growing season (attach an explanation of the basis for your conclusions)
☒	☐	The soil meets the Corps of Engineers regional criteria as a VERY POORLY DRAINED SOIL* and there is no evidence of altered hydrology
☐	☒	The soil meets the Corps of Engineers regional criteria as a POORLY DRAINED SOIL* and there is no evidence of altered hydrology
☐	☒	The soil meets the Corps of Engineers regional criteria as a SOMEWHAT POORLY DRAINED SOIL that has either of the following two characteristics*:

Yes	No	
☐	☐	1. Within 8 inches of the soil surface there are:
☐	☐	a. soil mottles within an A or Ap horizon and the subsoil is mottled throughout; OR
☐	☐	b. common to many, distinct or prominent mottles with a matrix of chrome 3 or less, OR
☐	☐	c. distinct or prominent oxidized rhizospheres and the subsoil is mottled throughout
☐	☐	2. Within 24 inches of the soil surface, there are mottles which are common to many, distinct or prominent, and that are chrome 3 or less, and one of the following:
☐	☐	a. In the horizon that lies within 10 inches of the soil surface and directly beneath a dark** A or Ap horizon, the matrix is chrome 3 or less; the mottles are at least 10% in abundance and distinct or prominent
☐	☐	b. When a dark** Ap horizon is between 10 and 14 inches thick, wetness morphology may be masked by organic matter. Normally, these problem situations will be considered hydric when: i. hydrophytes are prevalent, ii. there is no evidence of altered hydrology, and iii. in the horizon that lies directly beneath the Ap horizon, the matrix color is chrome 3 or less and mottles are at least 10% in abundance and distinct or prominent.

☐ Check here and attach a description of your procedures and conclusions if one of the following options were chosen for your hydric soil determination: measured redox potentials, colormetric test for ferrous iron test (α,α,-Dipyridil), or other measurements and observations.

* Typically in New England, soils having these morphologies will be classified in an aquic suborder or an aquic subgroup in soil taxonomy

** Note: a dark A or Ap is defined as having a value of 3 or less and a chrome of 2 or less

Remarks:

DATA & DETERMINATION HYDROLOGY

NOTE
1. Hydrology is often the most difficult feature to observe
2. Interpretations must consider the appropriateness of the observations in light of the season, recent weather conditions, and watershed alterations, etc
3. Interpretation of hydrology may require repeated observations over more than one season

☐ Recorded Data
- Stream, lake or tidal gage — Identification ______
- Aerial Photograph — Identification ______
- Other — Identification ______

☐ No Recorded Data Available

REPORT ANY OF THE FOLLOWING OBSERVATIONS

Depth to Free Water: 0"

Depth to Saturation: 0"

Describe Altered Hydrology: none

☒ Inundated

☒ Saturated in upper 12 inches

☒ Water Marks

☐ Drift Lines

☐ Sediment Deposits

☐ Drainage Patterns within Wetlands

Remarks: water stained leaves

CONCLUSIONS

Project Title:

Delineator:

Transect: Plot: Date:

	Yes	No
Greater than 50 Percent Hydrophytes?	☐	☐
Hydric Soils Criterion Met?	☒	☐
Wetland Hydrology Present?	☒	☐
IS THIS DATAPOINT WITHIN A WETLAND?	☐	☐

Remarks:

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P 36 & 37

Date: 6-21

Field Crew: Kim, Vangalio, Azzopardi

Photo #(s): 3-16

Cover Type No.: 2

Cover Type Name: Mixed forest

VEGETATION: (* = dominants)

Trees (DBH= veg. density= 90 %

white pine * white spruce
red oak red pine

Saplings/shrubs (veg. density=):

red maple low blueberry ironwood
red pine white oak A. chestnut

Woody Vines (veg. density= 0):

none

Herbs (veg. density= 15):

Canada mayflower wood fern sassparilla grasses
bracken fern wood pine starflower

Comments (diversity, quality, exotics):

- thick organic layer of needles
- relatively open understory

SOIL COMPOSITION: 10 YR 6/8 sandy

SLOPE: variable 10-20%

HYDROLOGY: absent

WATER BODIES: adjacent to pond and Marlboro Brook

WILDLIFE:

Species Observed:

chickadee
red squirrel

Other Evidence of Wildlife Use:

Wildlife Values:

___	travel corridors	___	cavity trees
✓	abundance of cover	___	standing dead snags
✓	abundance of food	___	large, contiguous fore:
✓	abundance of edge		

Available Wildlife Foods:

pine cones, acorns, berries

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums

- near roads

BASAL AREA FIELD FORM

Project: Sudbury Annex, P36 & 37
Cover type number: 2
Plot radius: ~30'

Date: 6-21
Crew: Kim, Vangalio, Azzopardi

DBH(in.)	Midpt.	BA/tree	SPECIES white pine	red oak	white spruce	red pine		
4-6	5	19.63	~~||||~~ ||	||||	|			
6-8	7	38.47	~~||||~~ |||	||				
8-10	9	63.59	|					
10-12	11	94.99		|				
12-14	13	132.67						
14-16	15	176.63	|					
16-18	17	226.87						
18-20	19	283.39						
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19				|		
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species			685.39	250.45	19.63	660.19		
Total BA/plot			1615.66 →					
Relative dominance (%)			42	16	1	41		

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

Project Title: Sudburry P36 P37

File Number:

Cover type 2 ~~Transect:~~ Plot:

Date: 6-21-93

DATA -- VEGETATION Stratum and Species (DOMINANTS ONLY)	Dominance Ratio	Percent Dominance	NWI. Status
Tree			
Pinus strobus	685.39/1615.66	42	FACU
Pinus resinosa	660.19/1615.66	41	FACU

Note: use asterisk * to indicate FAC-, FACU, or UPL species with observed adaptions to wetland hydrology

TALLY (Dominants ONLY)

OBL	FACW	FAC	*FAC-	*FACU	*UPL	FAC-	FACU	UPL

SUBTOTAL (HYDROPHYTES): ______ SUBTOTAL: 1

TOTAL: ______

$\frac{100 \times \text{SUBTOTAL (HYDROPHYTES)}}{\text{TOTAL}}$ = ______ = PERCENT HYDROPHYTES

DESCRIBE VEGETATION DISTURBANCE:

DESCRIBE ADAPTATIONS:

DATA -- SOIL Soil Taxonomy: Typic Udipsamment

Corps of Engineers Regional Drainage Class: excessively drained Criterion:

Is Published Soil Survey Available? Yes ☒ No ☐ Title/Date: Middlesex County 1991

Soil Type Mapped: Windsor Field Observations Confirm Type Mapped? Yes ☒ No ☐

Depth	Horizon	Matrix Color (Munsell, Moist)	Color of Mottles (Munsell, Moist) Abundance/Contrast	USDA Texture, iron or manganese nodules or concretions, restrictive layers, root distribution, oxidized rhizospheres, etc.
2-5		7.5YR 4/4		sandy
5-10		10YR 6/8		sandy

Remarks:

Sketch Landscape Position:

FOR USE WITH 1987 CORPS WETLANDS DELINEATION MANUAL

SOIL DETERMINATION

NOTE:
1. "NO" in all the following is evidence that the soil IS NOT HYDRIC
2. This checklist is valid for use by the New England Corps of Engineers; use outside the six New England States may be inappropriate
3. This interpretive routine may be inappropriate in unusual cases

Yes No

☐ ☐ Soil is frequently PONDED or FLOODED for a duration longer than two weeks during the growing season (attach an explanation of the basis for your conclusions)

☐ ☐ The soil meets the Corps of Engineers regional criteria as a VERY POORLY DRAINED SOIL* and there is no evidence of altered hydrology

☐ ☐ The soil meets the Corps of Engineers regional criteria as a POORLY DRAINED SOIL* and there is no evidence of altered hydrology

☐ ☐ The soil meets the Corps of Engineers regional criteria as a SOMEWHAT POORLY DRAINED SOIL that has either of the following two characteristics*:

Yes NO

☐ ☐ 1. Within 8 inches of the soil surface there are:

Yes No

☐ ☐ a. soil mottles within an A or Ap horizon and the subsoil is mottled throughout; OR

☐ ☐ b. common to many, distinct or prominent mottles with a matrix of chroma 3 or less; OR

☐ ☐ c. distinct or prominent oxidized rhizospheres and the subsoil is mottled throughout.

☐ ☐ 2. Within 24 inches of the soil surface, there are mottles which are common to many, distinct or prominent, and that are chroma 2 or less, and one of the following:

Yes No

☐ ☐ a. In the horizon that lies within 10 inches of the soil surface and directly beneath a dark** A or Ap horizon, the matrix is chroma 3 or less; the mottles are at least 10% in abundance and distinct or prominent.

☐ ☐ b. When a dark** Ap horizon is between 10 and 14 inches thick, wetness morphology may be masked by organic matter. Normally, these problem situations will be considered hydric when: I. hydrophytes are prevalent, II. there is no evidence of altered hydrology, and III. in the horizon that lies directly beneath the Ap horizon, the matrix color is chroma 3 or less and mottles are at least 10% in abundance and distinct or prominent.

☐ Check here and attach a description of your procedures and conclusions if one of the following options were chosen for your hydric soil determination: measured redox potentials, colormetric test for ferrous iron test (α,α,-Dipyridil), or other measurements and observations.

* Typically in New England, soils having these morphologies will be classified in an aquic suborder or an aquic subgroup in soil taxonomy.
** Note: a dark A or Ap is defined as having a value of 3 or less and a chroma of 2 or less

Remarks:

DATA & DETERMINATION HYDROLOGY

NOTE:
1. Hydrology is often the most difficult feature to observe
2. Interpretations must consider the appropriateness of the observations in light of the season, recent weather conditions, and watershed alterations, etc
3. Interpretation of hydrology may require repeated observations over more than one season

☐ Recorded Data:
Stream, lake or tidal gage — Identification: ______
Aerial Photograph — Identification: ______
Other — Identification: ______

☐ No Recorded Data Available

REPORT ANY OF THE FOLLOWING OBSERVATIONS:

Depth to Free Water: >18"

Depth to Saturation: >18"

Describe Altered Hydrology: ______

☐ Inundated

☐ Saturated in upper 12 inches

☐ Water Marks

☐ Drift Lines

☐ Sediment Deposits

☐ Drainage Patterns within Wetlands

Remarks

CONCLUSIONS

Project Title:

Delineator:

Transect: Plot: Date:

	Yes	No
Greater than 50 Percent Hydrophytes?	☐	☐
Hydric Soils Criterion Met?	☐	☒
Wetland Hydrology Present?	☐	☒

IS THIS DATAPOINT WITHIN A WETLAND? Yes ☐ No ☐

Remarks

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P36 & 37
Field Crew: Kim, Azzopardi, Vangalio

Date: 6-21
Photo #(s):
3-17, 18 & 19

Cover Type No.: 3
Cover Type Name: Open/disturbed

VEGETATION: (* = dominants)

Trees (DBH= veg. density= scattered
cottonwood (not in plot)

Saplings/shrubs (veg. density=):
low blueberry, red oak, paper birch, gray birch*, big tooth aspen
sweetfern, scotch pine, white pine, fire cherry*

Woody Vines (veg. density=):
rubus spp.

Herbs (veg. density=):
bush clover, asters, goldenrods, whorled loosestrife
sweet white clover, grasses*, cinquefoil

Comments (diversity, quality, exotics):
- trees and shrubs are located around the 2cd building (western)
- eastern end is more open/herbaceous

SOIL COMPOSITION: disturbed

SLOPE: 0-3 %

HYDROLOGY: absent

WATER BODIES: none (near Marlboro Brook)

WILDLIFE:

Species Observed:

Other Evidence of Wildlife Use:

Wildlife Values:
____ travel corridors
____ abundance of cover
____ abundance of food
____ abundance of edge
____ cavity trees
____ standing dead snags
____ large, contiguous fore

Available Wildlife Foods:
berries, catkins (buds + seeds)

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums
- paved areas, two sheet metal buildings, & roads

BASAL AREA FIELD FORM

Project: Sudbury Annex, P36 and 37
Cover type number: 3
Plot radius: ~30'

Date: 6-21
Crew: Kim, Vangalio, Azzopardi

DBH(in.)	Midpt.	BA/tree	SPECIES					
4-6	5	19.63						
6-8	7	38.47						
8-10	9	63.59						
10-12	11	94.99						
12-14	13	132.67						
14-16	15	176.63						
16-18	17	226.87						
18-20	19	283.39			No	Trees		
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species								
Total BA/plot								
Relative dominance (%)								

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P36 & 37
Field Crew: Azzopardi, Kim, Vangalio

Date: 6-21
Photo #(s): 3-20

Cover Type No.: 4
Cover Type Name: Oak forest

VEGETATION: (* = dominants)

Trees (DBH= veg. density= 50
red oak* red maple
scarlet oak*

Saplings/shrubs (veg. density= 80):
red maple low blueberry red oak sweetfern
A. chestnut white pine white oak scarlet oak

Woody Vines (veg. density= 0):
none

Herbs (veg. density= 10):
partridge berry bracken fern
wood pine grasses

Comments (diversity, quality, exotics):
• thick leaf litter

SOIL COMPOSITION: /

SLOPE: 2-4%

HYDROLOGY: absent

WATER BODIES: none

WILDLIFE:

Species Observed:
gypsy moths/catepillars ovenbird
red squirrel woodpecker (heard)

Other Evidence of Wildlife Use:

Wildlife Values:
___ travel corridors
_✓_ abundance of cover
_✓_ abundance of food
___ abundance of edge
___ cavity trees
_✓_ standing dead snags
___ large, contiguous fores

Available Wildlife Foods:
acorns, blueberries, seeds

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums

BASAL AREA FIELD FORM

Project: Sudbury Annex, P36 + 37
Cover type number: 4
Plot radius: ~30'

Date: 6-21
Crew: Vangalio, Kim, Azzopardi

DBH(in.)	Midpt.	BA/tree	SPECIES					
			red oak	scarlet oak	red maple			
4-6	5	19.63	|		||||			
6-8	7	38.47	|||		|			
8-10	9	63.59	||					
10-12	11	94.99	|					
12-14	13	132.67	|	|				
14-16	15	176.63	|					
16-18	17	226.87						
18-20	19	283.39						
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63		|				
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species			666.51	623.30	116.99			
Total BA/plot			1406.80 →					
Relative dominance (%)			47	44	9			

COVER TYPE DESCRIPTION FORM

Project: Sudbury Annex, P36 + 37
Field Crew: Vangalio, Azzopardi, Kim

Date: 6-21
Photo #(s): 3-21

Cover Type No.: 5
Cover Type Name: Pine plantation

VEGETATION: (* = dominants)

Trees (DBH= veg. density= 80
red pine* red oak
white pine scarlet oak

Saplings/shrubs (veg. density= 50):
A. chestnut red maple low blueberry
white pine red pine

Woody Vines (veg. density= 0):
none

Herbs (veg. density= 10):
pink ladyslipper bracken fern mosses (on trunks)
partridge berry

Comments (diversity, quality, exotics):
- thick leaf/needle layer
- planted

SOIL COMPOSITION: /

SLOPE: 0-3%

HYDROLOGY: absent

WATER BODIES: none

WILDLIFE:

Species Observed:
turkey (heard)
red squirrel

Other Evidence of Wildlife Use:

Wildlife Values:

- [ ] travel corridors
- [ ] abundance of cover
- [x] abundance of food
- [x] abundance of edge
- [ ] cavity trees
- [x] standing dead snags
- [ ] large, contiguous fores

Available Wildlife Foods:
pine cones, acorns, berries

DISTURBANCE: (fire, logging, ditching, stressed veg., stained soils, drums

Note: b. cherry, w. oak, g. birch, b.t. aspen, and r. oak occur along the outer edges along the roads + parking/paved areas

BASAL AREA FIELD FORM

Project: Sudbury Annex, P36 + 37
Cover type number: 5
Plot radius: ~ 30'

Date: 6-21
Crew: Vangalio, Azzopardi, Kim

DBH(in.)	Midpt.	BA/tree	SPECIES red pine	white pine	red oak	scarlet oak		
4-6	5	19.63	𝍸	𝍸	ll			
6-8	7	38.47	ll					
8-10	9	63.59	ll	ll		l		
10-12	11	94.99	lll	ll	l	l		
12-14	13	132.67						
14-16	15	176.63						
16-18	17	226.87						
18-20	19	283.39						
20-22	21	346.19						
22-24	23	415.27						
24-26	25	490.63						
26-28	27	572.27						
28-30	29	660.19						
30-32	31	754.39						
32-34	33	854.87						
34-36	35	961.63						
Total BA/species			587.24	415.31	134.25	158.58		
Total BA/plot			1295.38 →					
Relative dominance (%)			45	32	10	13		

APPENDIX L

RAPID BIOASSESSMENT REPORT

APPENDIX L

RAPID BIOASSESSMENT REPORT

L.1 INTRODUCTION

Rapid bioassessment (RBA) is a method of determining, in a short period of time with a moderate field effort, the biological condition of a stream or river, and whether or not the system is potentially impaired from its natural state. Rapid bioassessment of benthic macroinvertebrates have three protocols to choose from: Protocol I provides a screening level or reconnaissance assessment that involves the systematic documentation of specific visual observations; Protocol II provides a more intense assessment requiring the systematic collection and analysis of benthic taxa in the field; and Protocol III which involves a rigorous bioassessment including a systematic field collection and subsequent laboratory analysis of benthic taxa (EPA/444/4-89-001). Based on the SOW and level of effort chosen for this task, Protocol II was deemed appropriate to study the biological condition of streams at the Annex.

Protocol II involves the standardized collection, enumeration and identification of major benthic taxa (filters, scrappers, shredders) to the family level in riffle/run habitats. After the enumeration and identification of macroinvertebrates, eight distinct functional parameters (see page L-7) are measured and are combined into an overall score that evaluates the biotic integrity of the stream. This protocol can also be used in non-wadable streams or areas where suitable substrates are not available. Standard data sheets are used to trace each sampling location. Collections are compared to an off-site background stream, and an evaluation is made as to the impairment, or lack thereof, of the stream from input within the watershed. The stream can then be ranked as to its biological condition: non-impaired, moderately impaired, or severely impaired, where impaired is defined as a reduction in species comparable to the best situation to be expected within an ecoregion. Protocol II also involves stream habitat assessment such as stream flow, bottom characterizations, and riparian vegetation descriptions. In addition, water quality parameters such as dissolved oxygen (DO), temperature, pH, conductivity, odor, and turbidity are determined. These physical and chemical parameters are standard to many aquatic studies and are used to classify a station on the basis of its similarity to the expected condition, reference station, and its apparent potential to support an acceptable level of biological health.

L.2 SAMPLING METHODS

During 24 to 26 May 1993, an E & E field team surveyed and sampled four RBA sites at the Sudbury Training Annex. In the sampling plan, more sites were intended for sampling but were not sampled due to habitat conditions unsuitable for RBA analysis.

When a section of stream intended for RBA analysis was surveyed by the field team, the entire length was examined for the best location of riffle/run habitat with suitable

substrate. Once the RBA collection site was chosen, the Global Positioning System (GPS) was used to accurately identify the location and to record information about the site. Also, a labeled survey stake was placed in a visible spot and nearby trees were marked with survey tape. The stream width and depth were measured at several points at the site and an average was calculated. Using a portable field meter, the following water quality measurements were taken: temperature, dissolved oxygen, pH, and conductivity. All meters were calibrated for accuracy before use at each RBA site. Stream velocity was measured at both sides and the center of the stream with a portable meter.

Macroinvertebrate samples were collected at each RBA site by placing a small mesh kick net immediately downstream and then scrubbing (with a scrub brush) and kicking up the substrate in a ~1.0 square meter area. The collected material was then placed into a pre-gridded and numbered white plastic dish pan, approximately five centimeters square in area. Then, using fine tweezers, approximately 100 invertebrates were collected by randomly picking them from numbered squares in the grid. All organisms were placed into a pre-labeled, 8-ounce jar with sufficient isopropyl alcohol for preservation.

In the area immediately surrounding the RBA site and as close as possible to the stations, an undisturbed-course, particulate organic matter (CPOM) sample was collected from the stream with a kick net. The CPOM was placed into the white dish pan and all organisms were collected and jarred. If less than 50 organisms were collected, another CPOM sample was collected and the organisms added to the first sample.

Once the sampling process was completed, the collected invertebrates were identified to family level, enumerated, and placed into jars containing isopropyl alcohol mixed with water to preserve the samples for later use if required. All data collected during RBA sampling and analysis were recorded in field logbooks.

L.3 STREAM CHARACTERIZATION

The following provides a brief characterization of the existing environment at the four locations where an RBA was conducted. The RBA station on Taylor Brook is considered as a reference for all the other stations because it is the only one located outside and upgradient of the Annex. General location, vegetative density, stream bed composition, physical and chemical parameters as well as preliminary results are discussed for each location.

L.3.1 Taylor Brook

L.3.1.1 Station No. 1 (TB-1). This RBA station was designated as the reference station for the RBA study at the Annex. This station was located near headwaters of Taylor Brook in a physically undisturbed off-site, forested area, located behind the Digital Equipment Corporation's back parking lot (Plate 4). This designation was based primarily on the similarity of brook habitat, streambed composition, and infield measured physical and chemical water quality parameters at station TB-1 compared with site-impacted RBA stations. Station TB-1 was not a pristine macroinvertebrate environment primarily due to adjacent

human activity (Digital Equipment Corporation), but was the best available, off-site reference environment for the RBA study. Overall, it is believed that TB-1 can be used as a reference station to qualitatively assess the relative biotic integrity of the remaining stations.

At the time of the survey, the canopy closure was approximately 80 percent, and the steeply sloped stream banks were well vegetated. There were indications of bank erosion during high stream flows. The stream's bottom substrate consisted of approximately 15 percent cobble, 30 percent gravel, 40 percent sand, and 15 percent silt at the RBA station; other areas of the streambed were mostly sand and silt.

The average width of the stream at this site was 2 feet, and the average water depth was 3 inches. The average stream velocity was 0.01 meters per second (m/s). The water temperature was 15.5°C and the DO was 4.5 parts per million (ppm). The pH was 5.82, and the conductivity was measured at 179.4 micromhos per centimeter (μmhos).

The CPOM component for this site was very limited due to the high energy of the stream channel. There were only two small pockets of CPOM available for use.

A total of four orders of macroinvertebrates, of which six families were represented, were collected at this station.

L.3.2 Marlboro Brook

L.3.2.1 Station No. 1 (MB–1). This RBA station was located slightly downstream from the access road crossing and just downstream from the headwaters of Marlboro Brook near Site A11 (Plate 4). This station was located in a forested area, which had a canopy closure of approximately 90 percent. The stream banks were well vegetated but showed signs of moderate erosion and siltation occurring during high water periods. The stream bottom composition consisted of approximately 10 percent cobble, 30 percent gravel, 20 percent sand, 30 percent silt, and 10 percent clay. Much of the rock substrate available was most likely due to past road construction, since the stream bottom composition both upstream and downstream of this site was mostly sand and silt.

The average width of the stream was 3 feet, and the average depth was 3 inches. The average stream velocity was measured at 0.25 m/s. The water temperature was 13.4°C and the DO was 5.0 ppm. The pH was 5.25, and the conductivity was 26.9 μmhos.

Slight to moderate amounts of filamentous algae grew throughout the stream. In addition, CPOM was plentiful within the stream at the sampling location. Macroinvertebrate collection at this station identified four orders in which six families were represented.

L.3.2.2 Station No. 2 (MB–2). The second RBA station on Marlboro Brook was located downstream from the first site, and off of the Annex property (Plate 4). This site was downstream from the ponded area of Marlboro Brook before it crosses Surry Lane, behind some residential properties, and just below the remains of an old stone foot bridge.

The canopy closure was approximately 80 percent, and the stream banks were well vegetated. Some moderate signs of erosion during high water periods and some siltation were observed. The stream bed consisted of approximately 5 percent cobble, 40 percent gravel, 30 percent sand, and 25 percent silt. The available rocky substrate was a result of the degradation of the foot bridge's foundation, since stream bed composition upstream and downstream was mostly sand and silt.

The average width of the stream at this site was 3 feet and the average depth was 3 inches. The average stream velocity was 0.04 m/s. The water temperature was 12.8°C, and the DO was 3.6 ppm. The pH was 4.04, and the conductivity was 14.4 μmhos. The water was slightly stained a brownish color.

Throughout the stream sampling section, no macrophytic algae was found however, CPOM was present throughout the area. A total of six orders of macroinvertebrates in which 10 families were represented, were collected at this station.

L.3.3 Honey Brook

L.3.3.1 Station No. 1 (HB–1). This RBA station was located on the Annex, downstream from the Puffer Pond Road crossing of Honey Brook. The station was in a partially forested area just north of Puffer Pond Road, which had a canopy closure of approximately 10 percent. The stream banks were completely vegetated with little evidence of bank erosion or siltation in the channel. The stream bottom composition consisted of approximately 2 percent boulders, 40 percent cobble, 30 percent gravel, 20 percent sand, and 8 percent silt.

The average width of the stream was 2.5 feet, and the average depth was 9 inches. The average stream velocity was 0.08 m/s. The water temperature was 15.5°C, and the DO was 4.8 ppm. The pH was 6.34, and the conductivity was 26.8 μmhos. The water was slightly stained a brownish color.

Filamentous macrophytic algae was found throughout the area in varying amounts along with emergent vegetation. In addition, various pockets of CPOM were found within depositional areas through the site. Macroinvertebrate collected for this location revealed five orders in which 10 families were represented.

L.4 DISCUSSION OF RAPID BIOASSESSMENT RESULTS

The data analysis procedures used in the Rapid Bioassessment Protocol II (RBAII) integrate several community, population, and functional parameters into a single evaluation of biotic integrity. Each metric parameter measures a different component of community structure at each station and has a different range of sensitivity for induced impairment. There are eight metrics used in the RBAII. The benthic invertebrated data (family level only) are used to obtain a numerical value for each metric. The calculated values are then compared to values obtained from the background station and a biological condition score of

0, 3, or 6 is assigned to each station's metrics according to the comparability (percent similarity) of the calculated value and background value.

The eight metrics used in RBAII include:

- Taxa richness;
- Modified family biotic index (FBI);
- Ratio of scrapper to filtering collector functional feeding groups;
- Ratio of Ephemeroptera, Plecoptera, and Tricoptera (EPT) and Chironomidae abundances;
- Percent contribution of dominant family;
- EPT index;
- Community similarity indices;
- Ratio of shredder functional feeding group to the total number of individuals collected (Plafkin *et al.* 1989).

The following provides a brief discussion of what each metric value and score reflects and how each RBA station compares to the background station. In addition, Table L–1 provides the taxa counts for all five RBA stations; Table L–2 lists the water quality parameters at each station; Table L–3 gives the habitat assessment scores for all five stations; and Table L–4 identifies the percent contribution of dominant family at each station. Finally, Table L–5 summaries the biological condition scores achieved by each station when compared to the background station.

L.4.1 Taxa Richness

The taxa richness metric reflects the health of an aquatic community by measuring the total number of families present. The taxa richness score would increase with an increase in the number of different families present, and would be indicative of increased water quality, habitat diversity, and habitat suitability. Exceptions to this rule would be a naturally unproductive areas such as the headwaters of a stream (low score) or an organically enriched area which may be polluted but have a high score (Plafkin *et al.* 1989).

The taxa richness scores for the four RBA stations were: six for Taylor Brook (TB–1), which was the reference station; 6 for the first station on Marlboro Brook (MB–1); 10 for the second station on Marlboro Brook (MB–2); and 10 for Honey Brook (HB–1). Thus, all of the stations had a score for taxa richness that was equal to or greater than the reference station.

L.4.2 Modified Family Biotic Index

The modified Family Biotic Index (FBI) metric is based upon Hilsenhof's tolerance value ranges for families of the benthic arthropod community (EPA 1989). Tolerance values are used to calculate this metric score and can range from 0 to 10 with the higher values representing the more tolerant families. The modification used in this metric was developed by the State of New York so that other benthic organisms besides arthropods could be included. The formula for calculating the FBI metrics value is as follows:

$$FBI = \sum \frac{x_i \, t_i}{n}$$

Where x_i = number of individuals within a taxon.
t_i = tolerance value of a taxon.
n = total number of organisms in a sample.

The FBI has only been evaluated for organic pollutants although it may also be applicable for true pollutants (Plafkin *et al.* 1989). The modified FBI matrix values calculated for the RBA stations are: 4.3 at TB-1; 4.5 at MB-1; 3.8 at MB-2; and 3.9 at HB-1. The modified FBI scores for the reference station (TB-1), MB-1, MB-2, and HB-1 are all six for biological conditions.

L.4.3 Ratio of Scraper and Filtering Collection Functional Feeding Groups

The scraper and filtering collector metric reflects the health of an aquatic community by comparing the dominance of a particular feeding type to the reference station. This metric is independent of taxonomy since some families may contain several different feeding groups. This metric is based more upon morphological and behavioral features of the aquatic organisms. Scrapers tend to increase with diatom abundance and decrease as filamentous algae increases. A loss of scrapers may indicate contamination or organic enrichment. Filter collectors attach to sites and feed on Fine Particulate Organic Matter (FPOM). Since certain types of toxicants attach to dissolved organic matter which then forms some of the FPOM, the filter collectors are usually the first feeding group affected due to their ingestion of FPOM and their sensitivity to toxicants (Plafkin, *et al.* 1989). The scraper and filtering collector metric scores for TB-1 (reference), MB-2, and HB-1 were all at six. The metric score for MB-1 was 3 suggesting an impairment of the health of the aquatic community that may be due to a contamination source affecting MB-1 or to the road crossing being close to the station.

L.4.4 Ratio of EPT and Chironomidae Abundances

The ratio of Ephemeroptera, Plecoptera, and Tricoptera (EPT) to Chironomidae abundance metric, reflects the health of the aquatic community by measuring its balance using these indicator orders (EPT) and family (Chironomidae). A healthy biotic community would be reflected when there is essentially an even distribution of all four groups. Since the EPT

orders are inherently more sensitive to habitat and water quality degradation than the much more tolerant Chironomidae family, any increase in dominance by Chironomids would be a strong indicator of an increase in a toxicant or another environmental stress. In particular, Chironomids become more dominant in percent community composition and relative abundance when heavy metal concentrations increase (Plafkin *et al.* 1989).

The four RBA stations and the reference station have EPT and Chironomidae abundance metric scores as follows:

- TB–1 (reference) had an EPT/Chironomidae value of 9.13 and a metric score of 6.
- MB–1 had an EPT/Chironomidae value of 0.23 and a metric score of 0.
- MB–2 had an EPT/Chironomidae value of 50.0 and a metric score of 6.
- HB–1 had a EPT/Chironomidae value of 4.54 and a metric score of 3.

The lower scores of MB–1 and HB–1 could be an indication of contamination, or enrichment, but also may be due to disturbances and effects from the roads because both stations were located just downstream from roads.

L.4.5 Percent Contribution of Dominant Family

The percent contribution of dominant family metric is used to assess the health of the aquatic community by comparing the numerically dominant family to the rest of the community at a family level. A community that is dominated by a large percentage of only a few families would be an indication of some environmental stress (Plafkin *et al.* 1989).

The lowest scores are assigned to RBA stations whenever a single family dominates the total number of organisms by more than 50 percent. Table L–5 shows the dominant families for each RBA station and indicates the percent contribution of the dominant family and the metric value score. All of the RBA stations except HB–1 had dominant families over 50 percent, with HB–1 at 46 percent.

L.4.6 EPT Index

The EPT index metric measures the health of the aquatic community by determining the total number of taxonomic families within the orders Ephemeroptera, Plecoptera, and Tricoptera (EPT). These groups are generally considered to be the most sensitive to pollution. The EPT index should increase with better water quality. An exception to this would be naturally unproductive areas, such as headwaters, which would experience an EPT index increase in response to organic enrichment (Plafkin *et al.* 1989).

The EPT index valve and metric score for TB-1 (background) are 2 and 6, respectively; 2 and 6 at MB-1; 4 and 6 at MB-2; and at HB-1 they are 6 and 6, respectively. When compared to the reference station all of the RBA stations scored equally or higher which suggests that a healthy aquatic community, as measured by the EPT index, exists at each of the studied stations.

L.4.7 Community Similarity Indices

The community similarity indices metric offers several different ways to compare the RBA stations benthic communities to the reference station. The index chosen for this project's metric is the Community Loss Index, which measures the loss of benthic taxa between the reference station and an RBA station. This is an index of compositional dissimilarity; the index values increase as the degree of dissimilarity with the reference station increases. Therefore, if the reference station represents a typical, non-impacted stream community in the area, RBA stations may then be judged on their similarity or dissimilarity, in benthic family composition to the reference station (Plafkin *et al.* 1989).

The community loss index/community similarity index values for the three RBA stations when compared to the reference station (TB-1) are 0.50 for MB-1, 0.63 for MB-2, and 0.50 for HB-1. The metric scores are 3 for all these stations showing that they all have a moderate amount of dissimilarity from the reference station.

L.4.8 Ratio of Shredder Functional Feeding Group and Total Number of Individuals Collected

As with the scraper/filtering collector metric, the shredder functional feeding group metric is based on the functional feeding group concept and not on taxonomy. This metric allows evaluation of the health of aquatic communities based upon potential impairment as indicated by the CPOM-dependent shredder community. The shredder community is a good indicator of riparian zone impacts, since shredders feed on the CPOM (leaves) in the stream and are sensitive to the toxic effects when contaminants are absorbed into the CPOM. The effects of a toxicant on the shredders versus the filters depends upon the nature of the toxicant and the organic particle adsorption efficiency. Toxicants such as pesticides and herbicides tend to accumulate in CPOM thus affecting the shredders directly (Plafkin *et al.* 1989).

The ratio of shredder functional feeding groups to the total number of individuals collected is 0.87 at TB-1; 0.35 at MB-1, 0.00 at MB-2, and 0.77 at HB-1. The metric scores for TB-1 and HB-1 were 6 while MB-1 was 3 and MB-2 received a 0.

The low score for station MB-2 might be an indication of contamination such as pesticides and/or herbicides, but since this station was downstream of the Sudbury Annex property and near some residential areas, it is unclear where the source maybe originating. Additionally, the low score for MB-1 is most likely due to proximity and associated over-burden coming from an area of the base main roads.

L.4.9 Summary

When examining the results of the RBA study, it is important to note that comparisons of potentially contaminated locations to the off-site reference location are qualitative in nature. The intent of the study was to collect biotic data to qualitatively supplement the chemical data for surface water and sediment.

Taking the total RBA metric values scores of the three on-site RBA stations and comparing them as a percent to the reference station total metric score, the following results were determined (Table 6-5):

MB-1 = 50 percent

MB-2 = 79 percent

HB-1 = 81 percent

According to the Rapid Bioassessment Protocols (Plafkin *et al.* 1989), any percentage above 79 percent when compared to the reference location, should be considered "non-impaired, with conditions equal to what can best be expected in the regional area with respect to stream size and habitat quality." RBA station MB-2 and HB-1 results indicate that the lower Marlboro Brook and Honey Brook systems appear to be non-impaired relative to the reference station, TB-1 (Taylor Brook). This suggests that contamination or other disturbances of these streams are no greater than for Taylor Brook at the reference point, TB-1. The result for station HB-1 is quantitatively supported by the results from the surface water and sediment sample taken at RBA station HB-1 at sample point E3-P11-D03. Sampling data at this point are described in the Site P11 section of this report (Section 2.2.3.7, Volume II), and indicate similar chemical concentrations in surface water and sediments at E3-P11-D03, and in samples taken at the reference station TB-1 at sample location E3-BCK-D01 (see Appendix J).

The result for station MB-2 could not be quantitatively assessed as surface water/sediment samples were not taken at this RBA station. The nearest upstream samples were taken at E3-P37-D03, and contained elevated pesticides and metals, but are located at least 1,200 feet upstream of RBA station MB-2 and above the nearby pond.

When percentage comparisons are between 29 and 72 percent of the background reference, these stations are considered to be "moderately impaired." This moderate impairment results from fewer species of the most intolerant forms and reductions in the EPT index. RBA station MB-1 had a percent value of 50 percent indicating the area may be experiencing some moderate impairment in relation to the reference station, TB-1. This qualitative result can be quantitatively supported by analytical data from the surface water/sediment sample taken at E3-A11-D01 (see Section 3.2.2.7). The analytical data showed this area to have the elevated levels of contaminants in surface water compared to the

other RBA stations and the reference station. The RBA result may be the result of contamination from site-related sources, but may also be due to the stations close proximity to the road, potentially unproductive headwaters, and stream ponding on the upstream side of the road.

L.5 REFERENCES

Cummins, K.W. and R.W. Merritt, 1984. An Introduction to the Aquatic Insects of North America, Second Edition. Kendoll/Hunt Publishing Company, Dubuque, Iowa, 722p.

Lehmkuhl, D.M., 1979. How to Know the Aquatic Insects. Wm. C. Brown Company Publishers, Dubuque, Iowa, 168p.

Plafkin, J. L., M.T. Barbour, R.D. Porter, S.K. Gross, and R.M. Hughs. Rabid Bioassessment 1989. Protocols for use in stream and rivers, Benthic Macroinvertebrates and Fish. EPA, EPA/440/4-89-001. 161p.

Ward, H.B. and G.C. Whipple. 1956. Freshwater Biology, Second Edition. John Wiles and Sons Inc., N.Y. 1248p.

Table L-1

RAPID BIOASSESSMENT TAXA COUNTS

Order and Family	Rapid Bioassessment Stations (Number of RBA Organisms/Number of CPOM Organisms)			
	TB-1	MB-1	MB-2	HB-1
Ephemeroptera				
Heptageniidae	0/0	00	16/4	0/0
Ephemerellidae	0/0	0/0	2/6	0/0
Trichoptera				
Psychomiidae	0/0	3/7	0/0	0/0
Hydropsychidae	70/0	0/0	80/11	2/0
Limnephilidae	3/2	7/5	2/0	38/26
Lepidostomatida	0/3	0/0	0/0	5/2
Molannidae	0/0	0/0	0/1	4/2
Glossosomatidae	0/0	0/0	0/0	1/1
Plecoptera				
Nemouridae	0/0	0/0	0/0	9/2
Diptera				
Tipulidae	4/1	43/0	2/17	13/6
Simuliidae	12/0	25/2	2/0	6/1
Chironomidae	8/2	43/0	2/17	13/6
Megaloptera				
Sialidae	0/0	1/0	3/0	4/0
Anisoptera				
Aeshnidae	0/1	0/0	0/0	0/2
Cordulegastridae	0/1	0.1	4/6	0/0
Amphopoda				
Gammaridae	10/42	0/5	7/0	0/12
Total Organisms	107/51	82/21	123/44	83/55
Total Number of Orders	3/4	3/4	6/4	4/5
Total Number of Families	6/6	6/6	10/6	10/10
Metric Value Score	6	6	6	6

Key: TB = Taylor Brook (background).
MB = Marlboro Brook.
HB = Honey Brook.

Source: Ecology and Environment, Inc. 1994.

Page 1 of 1

Table L-2

RAPID BIOASSESSMENT WATER QUALITY

Parameter	Rapid Bioassessment Stations			
	TB-1	MB-1	MB-2	HB-1
Temperature (°C)	15.5	13.4	12.8	15.5
Dissolved Oxygen (ppm)	5.82	5.0	3.6	4.8
pH (units)	5.82	5.25	4.04	6.34
Conductivity (μmhos)	179.4	26.9	14.4	26.8
Color (observed)	Clear	Clear	Brownish	Brownish
Turbidity (observed)	None	None	Slight	None

Key:

TB = Taylor Brook (background).
MB = Marlboro Brook.
HB = Honey Brook.

Source: Ecology and Environment, Inc. 1994.

Table L–3

RAPID BIOASSESSMENT STATION HABITAT ASSESSMENT SCORES

Parameter	Rapid Bioassessment Stations			
	TB–1	MB–1	MB–2	HB–1
Bottom substrate/available cover	10	10	15	15
Embeddedness	15	15	15	15
Flow	10	10	10	10
Channel alteration	7	7	7	11
Bottom scouring and deposition	7	11	7	11
Pool/riffle, run/bend ratio	7	7	7	11
Bank stability	5	5	5	8
Bank vegetative stability	8	8	10	8
Stream side cover	8	8	8	5
Score	77	81	84	94
Percent Comparison with TB–1 (background)	----	105	109	122

Key:

TB = Taylor Brook (background).
MB = Marlboro Brook.
HB = Honey Brook.

Source: Ecology and Environment, Inc. 1994.

Table L-4

PERCENT CONTRIBUTION OF DOMINANT FAMILY FOR RAPID BIOASSESSMENT STATIONS

Rapid Bioassessment Stations	Number of Organisms in RBA Sample	Dominant Family	Number of Organisms in Dominant Family	Percent Contribution of Dominant Family	Metric Value Score
TB-1	107	Hydropsychidae	70	65	0
MB-1	82	Chironomidae	43	52	0
MB-2	123	Hydropsychidae	80	65	0
HB-1	83	Limmephilidae	38	46	3

Key:

TB = Taylor Brook (background).
MB = Marlboro Brook.
HB = Honey Brook.

Source: Ecology and Environment, Inc. 1994.

Table L-5

SUMMARY OF BIOLOGICAL CONDITION SCORES

Metrics	Rapid Bioassessment Station (Biological Condition Scores)			
	TB-1 Background	MB-1	MB-2	HB-1
Taxa Richness	6	6	6	6
Family Biotic Index (Modified)	6	6	6	6
Ratio of Scrapers/Filter Collector	6	3	6	6
Ratio of EPT and Chironomid Abundance	6	0	6	3
Percent Contribution of Dominant Family	0	0	0	3
EPT Index	6	0	6	6
Community Loss Index	6	3	3	3
Ration of Shredders/Total	6	3	0	6
Total Score	42	21	33	39
Percent Comp to Ref Score	—	50	79	93

Key:

TB = Taylor Brook (Background).
MB = Marlboro Brook.
HB = Honey Brook.

Source: Ecology and Environment, Inc. 1994.

APPENDIX M

IRDMIS LEVEL 3 DATA

APPENDIX M

IRDMIS LEVEL 3 DATA

All IRDMIS Level 3 analytical data generated for the investigations at the Annex, including QA/QC data, are presented in electronic format on the enclosed diskettes. The first diskette contains data from E & E's first three sampling mobilizations in condensed-format files which will produce ASCII data tables when expanded. Instructions for accessing the analytical data tables and further information on the table formats are given in the file README.TXT.

The second diskette contains only analytical data generated during the April 1994 sampling mobilization. As these data sets are relatively small, they are included on the diskette already in ASCII format.

FILE: README.TXT

The enclosed 3.5" diskette contains all IRDMIS level 3 data produced during the environmental investigations performed by Ecology and Environment, Inc. at the Fort Devens Sudbury Annex (prior to April 1994). These data are stored on this diskette in two self-extracting files: SD_DATA.EXE, and SD_QC.EXE. The first file contains the field sampling analytical data, and the second file contains the QA/QC analytical data. Data extracted from these files will be in ASCII format.

To extract the information from the files on this diskette, simply copy the file(s) to the PC which is to hold the information, and type the name of the file. For example, to obtain the ASCII QC data, copy the file SD_QC.EXE to the target PC and type:

```
C:\> SD_QC
```

Structure of SD_DATA.TXT (Analytical Data in ASCII Format):

Field Name	Columns	Type	Description
SA	1-3	Character 3	Study area
INST	4-5	Character 2	Installation
LAB	6-7	Character 2	Lab
LOT	8-11	Character 4	Lot identifier
SITE_TYPE	12-15	Character 4	Site type
MEDIA_TYPE	16-18	Character 3	Sample matrix
SITE_ID	19-28	Character 10	Site id
F_SAMPLE_N	29-36	Character 8	Field sample number
SAMP_DATE	37-47	Character 11	Sample date
DEPTH	48-52	Numeric 5,1	Depth (in feet)
METH	53-56	Character 4	Analytical method code
METH_MATRI	57	Character 1	Analytical matrix (solid or water)
TEST_NM	58-63	Character 6	Analyte code
MEAS_BOOL	64-65	Character 2	Measurement code (LT or ND or blank)
VALUE	66-79	Numeric 14,5	Analytical result
UNIT_MEAS	80-83	Character 4	Units
FLAG	84-87	Character 4	Data useability codes
WATERSHED	88-90	Character 2	Watershed (1A, 1B, 2, 3, 4, 5, 6)

Expanded file (SD_DATA.TXT) = 5,862,767 bytes

Structure of SD_QC.TXT (QC Data in ASCII Format):

Field Name	Columns	Type	Description
SA	1-3	Character 2	Study area (AOC)
INST	4-5	Character 2	Installation
LAB	6-7	Character 2	Lab
LOT	8-11	Character 4	Lot identifier
SITE_TYPE	12-15	Character 4	Site type
MEDIA_TYPE	16-18	Character 3	Sample matrix
SITE_ID	19-28	Character 10	Site id
F_SAMPLE_N	29-36	Character 8	Field sample number
SAMP_DATE	37-47	Character 11	Sample date
DEPTH	48-52	Numeric 5,1	Depth (in feet)
METH	53-56	Character 4	Analytical method code
METH_MATRI	57	Character 1	Analytical matrix (solid or water)
TEST_NM	58-63	Character 6	Analyte code
MEAS_BOOL	64-65	Character 2	Measurement code (LT or ND or blank)
VALUE	66-79	Numeric 14,5	Analytical result
QC_TYPE	80	Character 1	Type of QC sample
SPIKE	81-94	Numeric 14,5	Spike amount (if any)
UNIT_MEAS	95-98	Character 4	Units
FLAG	99-102	Character 4	Data useability codes
WATERSHED	103-105	Character 2	Watershed identifier

Expanded file (SD_QC.TXT) = 4,585,993 bytes

FILE: README.TXT

The enclosed 3.5" diskette contains all IRDMIS level 3 data produced during the April 1994 sampling mobilization performed by Ecology and Environment, Inc. at the Fort Devens Sudbury Annex. These data are stored on this diskette in two ASCII text files: APR_DATA.TXT, and APR_QC.TXT. The first file contains the field sampling analytical data, and the second file contains the QA/QC analytical data.

Structure of APR_DATA.TXT (Analytical Data in ASCII Format):

Field Name	Columns	Type	Description
SA	1-3	Character 3	Study area
INST	4-5	Character 2	Installation
LAB	6-7	Character 2	Lab
LOT	8-11	Character 4	Lot identifier
SITE_TYPE	12-15	Character 4	Site type
MEDIA_TYPE	16-18	Character 3	Sample matrix
SITE_ID	19-28	Character 10	Site id
F_SAMPLE_N	29-36	Character 8	Field sample number
SAMP_DATE	37-47	Character 11	Sample date
DEPTH	48-52	Numeric 5,1	Depth (in feet)
METH	53-56	Character 4	Analytical method code
METH_MATRI	57	Character 1	Analytical matrix (solid or water)
TEST_NM	58-63	Character 6	Analyte code
MEAS_BOOL	64-65	Character 2	Measurement code (LT or ND or blank)
VALUE	66-79	Numeric 14,5	Analytical result
UNIT_MEAS	80-83	Character 4	Units
FLAG	84-87	Character 4	Data useability codes
WATERSHED	88-90	Character 2	Watershed (1A, 1B, 2, 3, 4, 5, 6)

Structure of APR_QC.TXT (QC Data in ASCII Format):

Field Name	Columns	Type	Description
SA	1-3	Character 2	Study area (AOC)
INST	4-5	Character 2	Installation
LAB	6-7	Character 2	Lab
LOT	8-11	Character 4	Lot identifier
SITE_TYPE	12-15	Character 4	Site type
MEDIA_TYPE	16-18	Character 3	Sample matrix
SITE_ID	19-28	Character 10	Site id
F_SAMPLE_N	29-36	Character 8	Field sample number
SAMP_DATE	37-47	Character 11	Sample date
DEPTH	48-52	Numeric 5,1	Depth (in feet)
METH	53-56	Character 4	Analytical method code
METH_MATRI	57	Character 1	Analytical matrix (solid or water)
TEST_NM	58-63	Character 6	Analyte code
MEAS_BOOL	64-65	Character 2	Measurement code (LT or ND or blank)
VALUE	66-79	Numeric 14,5	Analytical result
QC_TYPE	80	Character 1	Type of QC sample
SPIKE	81-94	Numeric 14,5	Spike amount (if any)
UNIT_MEAS	95-98	Character 4	Units
FLAG	99-102	Character 4	Data useability codes
WATERSHED	103-105	Character 2	Watershed identifier

APPENDIX N

LEGEND OF GROUND FEATURES

Note

The legend in this Appendix is intended for use as an underlay for site maps in Volume II of this report.

Legend of Ground Features:

Approximate Watershed Boundary

Paved Road

Unimproved Road

Water Body

Stream

Railroad

Fence

Installation Boundary

Trees

200 Contour (5' Interval)

Wetland

APPENDIX O

WATER QUALITY PARAMETERS

APPENDIX O

WATER QUALITY PARAMETERS

This Appendix presents the physical characteristics measured in the field to assess the water quality of streams, ponds, and groundwater monitoring wells prior to sampling. The following characteristics were measured using a Horiba U-10 Water Quality Meter: pH, conductivity, turbidity, dissolved oxygen, and temperature. In some instances it was not possible to measure certain water quality parameters due to equipment failure caused by adverse field/weather conditions. These instances are noted on the tables.

WATER QUALITY PARAMETERS

Surface Water

TABLE O-1
WATER QUALITY PARAMETERS FOR SURFACE WATER SAMPLES

SAMPLE LOCATION	DATE	pH	COND µS/cm	TURB	DO µg/L	TEMP (C°)
Upper Taylor Brook Watershed-1A						
E3-BCK-D01	09/15/93	6.90	0.29	NA	6.30	20.00
E3-BCK-D04	09/17/93	6.79	0.14	140.00	9.70	16.00
E3-PUF-011	11/05/93	6.85	0.06	13.00	10.16	7.20
E3-PUF-021	11/05/93	6.85	0.06	7.00	10.23	7.00
E3-PUF-031	11/05/93	6.77	0.06	4.00	10.13	6.90
E3-PUF-041	11/05/93	6.77	0.06	4.00	10.11	6.90
E3-PUF-051	11/05/93	6.76	0.06	4.00	10.04	6.90
E3-PUF-061	11/05/93	6.68	0.06	4.00	9.66	6.90
Lower Taylor Brook Watershed-1B						
E3- P11- D01	12/01/93	3.78	0.08	35.00	NA	1.70
E3- P11- D02	12/01/93	3.98	0.10	1.00	NA	2.70
E3- P11- D03	09/15/93	6.80	0.05	10.00	4.90	23.00
E3- P11- D04	12/02/93	NA	NA	NA	NA	NA
E3- P13- D01	08/02/93	6.84	0.12	39.00	9.19	24.40
E3- P13- D01	12/01/93	6.08	0.10	5.00	NA	7.60
E3- P13- D03	12/01/93	3.78	0.10	4.00	NA	3.90
E3- P13- D04	12/01/93	5.52	0.07	1.00	NA	3.30
E3- P13- D05	12/01/93	5.48	0.08	1.00	NA	2.80
E3- P26- D01	08/04/93	6.78	0.11	10.00	10.81	18.20
E3- P26- D02	08/04/93	6.67	0.06	10.00	10.82	19.00
E3- P26- D03	08/05/93	4.64	0.06	>999	10.05	19.60
E3- P26- D04	08/05/93	6.15	0.06	183.00	12.06	15.30
E3- P42-D01	08/03/93	6.27	0.89	10.00	8.64	28.70
E3-P45-D01	09/29/93	6.60	0.06	20.00	7.80	18.00
E3-BCK-D05	09/22/93	7.30	0.04	10.00	6.30	13.00
E3-BCK-D08	09/21/93	6.90	0.09	0.00	6.10	8.00
Hop Brook Watershed-2						
E3- A10- D01	08/10/93	3.84	0.20	10.00	2.04	18.10
E3- A10- D02	12/02/93	NA	NA	NA	NA	NA
E3- A11- D01	09/15/93	6.90	0.08	NA	11.40	19.00
E3- A11- D02	09/15/93	6.40	0.04	NA	6.40	19.00
E3- P37- D01	09/16/93	5.60	0.08	>999	1.70	14.00
E3- P37- D02	09/16/93	6.10	0.03	218.00	6.10	18.00
E3- P37- D03	09/16/93	6.50	0.04	180.00	5.70	15.00
Lower Assabet River Watershed-3						
E3-BCK-D03	09/17/93	7.90	0.09	22.00	11.70	13.00
Upper Assabet River Watershed-4						
E3-BCK-D02	09/22/93	6.50	0.06	50.00	4.30	12.00
Lake Boon Watershed-5						
E3-A05- D01	09/20/93	5.50	0.04	10.00	3.20	10.00
E3-P58-D01	12/02/93	NA	NA	NA	NA	NA
Minister's Pond						
E3-OFF-011	11/09/93	6.61	0.17	4.00	6.29	5.90
E3-OFF-021	11/09/93	6.45	0.17	4.00	6.07	6.00
E3-OFF-031	11/09/93	6.56	0.17	4.00	6.07	5.30
E3-OFF-041	11/09/93	6.51	0.18	7.00	6.03	5.40
E3-OFF-051	11/09/93	6.54	0.18	4.00	4.92	5.80
E3-OFF-061	11/09/93	6.45	0.17	7.00	5.26	4.40

Key
NA = Not Available

Source: Ecology and Environment, Inc. 1994

WATER QUALITY PARAMETERS

Groundwater

Table O-2 WATER QUALITY PARAMETERS FOR GROUNDWATER						
SAMPLE LOCATION	DATE	pH	COND (μS/cm)	TURB	DO (μg/L)	TEMP (C°)
Upper Taylor Brook Watershed-1A						
OHM-P6-25	08/26/93	4.96	0.046	<10.00	3.20	9.50
OHM-P6-26	08/26/93	5.66	0.058	43.00	3.35	10.90
OHM-P6-27	08/26/93	5.45	0.023	<10.00	7.71	9.60
GZA-MW1	09/03/93	6.44	0.045	8.40	191.00	12.00
MAYNARD03	09/03/93	NA	NA	NA	NA	NA
TW14	09/02/93	5.31	0.036	325.00	6.10	9.90
Lower Taylor Brook Watershed-1B						
E3-A02-M01	08/27/93	NA	NA	NA	NA	NA
E3-A02-M01	08/31/93	NA	NA	NA	NA	NA
E3-A02-M01	12/03/93	5.75	0.074	3.00	NA	10.00
E3-P11-M01	08/24/93	9.30	0.108	13.00	0.05	11.80
E3-P11-M01	11/30/93	6.30	0.07	990.00	NA	9.00
OHM-P11-32	08/25/93	5.97	0.064	970.00	8.86	13.60
OHM-P11-32	11/30/93	6.60	0.03	0.00	NA	10.00
OHM-P11-33	08/25/93	NA	NA	NA	NA	NA
OHM-P11-33	11/30/93	NA	NA	NA	NA	NA
ATEC-1	09/02/93	5.31	0.044	461.00	5.29	17.10
ATEC-1	11/30/93	5.40	0.06	550.00	1.70	12.00
ATEC-2	09/02/93	5.60	0.076	870.00	7.96	19.10
ATEC-2	11/30/93	5.40	0.06	550.00	1.70	12.00
EHA3	11/30/93	5.65	0.132	3.00	0.20	10.70
E3-P13-M01	08/25/93	6.00	0.191	943.00	13.17	12.30
E3-P13-M01	11/29/93	6.70	0.22	0.8	NA	14.00
E3-P13-M02	08/24/93	5.72	0.495	151.00	3.52	14.70
E3-P13-M02	11/30/93	6.90	0.08	8.00	NA	12.00
E3-P13-M03	08/25/93	NA	NA	NA	NA	NA
E3-P13-M03	11/30/93	5.70	0.27	30.00	NA	8.00
E3-P13-M04	08/24/93	5.16	0.036	340.00	7.25	15.70
E3-P13-M04	11/29/93	5.00	0.03	30.00	NA	11.00
E3-P23-M01	08/26/93	NA	NA	NA	NA	NA
E3-P23-M01	12/02/93	NA	NA	NA	NA	NA
E3-P26-M01	08/26/93	NA	NA	NA	NA	NA
E3-P26-M01	12/01/93	5.45	0.055	1.00	0.07	10.50
E3-P26-M02	01/10/93	NA	NA	NA	NA	NA
E3-P26-M02	08/26/93	NA	NA	NA	NA	NA
E3-P26-M02	12/03/93	NA	NA	NA	NA	NA
E3-P26-M03	01/11/93	NA	NA	NA	NA	NA
E3-P26-M03	08/26/93	NA	NA	NA	NA	NA
E3-P26-M03	12/03/93	NA	NA	NA	NA	NA
Hop Brook Watershed-2						
A10-DM1	09/01/93	5.07	0.038	<10.00	7.25	9.80
A10-DM11	09/01/93	5.30	0.032	<10.00	4.72	12.50
A10-DM7	09/01/93	5.74	0.055	<10.00	3.31	11.40
E3-A10-M01	08/24/93	4.79	0.060	10.00	5.39	9.00
E3-A10-M01	12/03/93	5.66	0.110	2.00	NA	6.80
E3-A10-M01	01/12/94	NA	NA	NA	NA	NA
OHM-A10-19	09/01/94	5.57	0.050	<10.00	4.64	11.40
OHM-A10-20	09/01/94	5.10	0.025	>999	8.45	8.90
OHM-A11-21	08/30/93	5.65	0.051	110.00	2.72	11.30
OHM-A11-21	08/30/93	NA	NA	NA	NA	NA
OHM-A11-23	08/30/93	5.09	0.031	<10.00	2.40	10.10
E3-P36-M01	08/09/93	6.03	0.085	>999	NR	17.30
E3-P36-M01	09/01/93	5.78	0.098	<10.00	4.90	15.20
E3-P36-M01	12/01/93	6.60	0.07	240.00	NA	12.00
E3-P36-M02	09/02/93	6.08	0.051	<10.00	7.69	14.10
E3-P36-M02	12/01/93	6.70	0.03	30.00	NA	13.00
E3-P36-M03	09/02/93	5.96	0.061	<10.00	6.58	14.10
E3-P36-M03	12/01/93	6.60	0.04	10.00	NA	13.00

Key at end of table.

Table O-2
WATER QUALITY PARAMETERS FOR GROUNDWATER

SAMPLE LOCATION	DATE	pH	COND (μS/cm)	TURB	DO (μg/L)	TEMP (C°)
Hop Brook Watershed-2 (continued)						
E3-P37-M01	09/02/93	5.71	0.077	<10.00	7.45	15.70
E3-P37-M01	12/01/93	6.40	0.06	340.00	NA	6.40
E3-P37-M02	09/02/93	5.71	0.080	<10.00	6.63	15.30
E3-P37-M02	12/01/93	6.40	0.04	10.00	NA	12.00
E3-P37-M03	09/01/93	5.60	0.048	<10.00	9.11	12.20
E3-P37-M03	12/01/93	NA	NA	NA	NA	NA
OHM-P48-41	08/30/93	5.32	0.034	<10.00	5.08	12.50
OHM-P48-42	08/30/93	4.28	0.037	<10.00	4.49	10.50
OHM-P48-43	08/30/93	4.94	0.036	<10.00	3.55	12.30
Lower Assabet River Watershed-3						
OHM-A8-14	08/27/93	NA	NA	NA	NA	NA
OHM-A8-14	08/31/93	NA	NA	NA	NA	NA
OHM-A8-15	08/27/93	NA	NA	NA	NA	NA
OHM-A8-15	08/30/93	NA	NA	NA	NA	NA
OHM-A9-16	08/27/93	NA	NA	NA	NA	NA
OHM-A9-16	08/30/93	8.17	0.062	0.024	7.20	11.70
OHM-A9-47	08/27/93	7.75	0.061	121.00	7.20	17.70
OHM-A9-49	08/30/93	NA	NA	NA	NA	NA
OHM-P9-16	08/27/93	8.17	0.062	0.024	NA	NA
E3-P57-M01	01/11/93	NA	NA	NA	NA	NA
E3-P57-M01	08/25/93	NA	NA	NA	NA	NA
E3-P57-M01	12/03/93	NA	NA	NA	NA	NA
Upper Assabet River Watershed-4						
E3-A06-M01	08/26/93	NA	NA	NA	NA	NA
E3-A06-M01	12/02/93	NA	NA	NA	NA	NA
USAF	09/03/93	NA	NA	NA	NA	NA
E3-P22-M01	08/31/93	5.43	0.033	85.00	6.70	16.70
E3-P22-M01	12/02/93	NA	NA	NA	NA	NA
Lake Boon Watershed-5						
A5-DM6	09/02/93	5.53	0.024	<10.00	9.53	12.70
E3-A05-M01	09/17/93	7.70	0.13	250.00	2.90	11.00
OHM-A5-24	09/02/93	5.31	0.023	<10.00	9.08	10.50
OHM-A5-44	09/02/93	4.90	0.022	19.00	6.96	11.70
E3-P31-M01	09/01/93	6.12	0.175	266.00	2.54	11.90
E3-P31-M01	12/03/93	6.06	0.110	4.00	NA	10.90
E3-P58-M01	09/02/93	5.90	0.101	<10.00	1.08	15.20
E3-P58-M01	12/02/93	5.90	0.10	0.00	NA	11.00
E3-P58-M02	09/02/93	5.62	0.076	830.00	1.10	10.20
E3-P58-M02	12/02/93	5.70	0.06	20.00	NA	9.00
P40-EH41	08/30/93	5.26	0.039	<10.00	5.01	10.50
OHM-P40-29	08/31/93	10.12	0.271	458.00	1.04	14.20
OHM-P40-38	08/30/93	4.85	0.061	<10.00	3.76	13.40
OHM-P40-39	08/31/93	4.91	0.052	<10.00	4.79	13.70
EHA1	08/30/93	NA	NA	NA	NA	NA
Willis Pond and Crystal Lake Watershed-6						
E3-P02-M01	08/31/93	6.01	0.157	<10.00	6.89	14.40
E3-P02-M01	12/03/93	5.81	0.046	401.00	NA	8.20
E3-P02-M01	01/11/93	NA	NA	NA	NA	NA
ATEC-P1P3	09/02/93	6.44	0.229	>999	8.72	14.70
E3-P03-M01	09/03/93	6.85	0.130	>999	5.59	15.30
E3-P03-M01	09/16/93	6.50	0.11	>999	1.70	12.00
E3-P03-M01	12/03/93	7.29	0.081	963.00	NA	10.60
E3-P03-M02	08/31/93	7.73	0.052	999.00	9.12	'5.00

Key: NA = Not Available

Source: Ecology and Environment, Inc. 1994.

APPENDIX P

WATER LEVEL MEASUREMENTS AND GROUNDWATER ELEVATION DATA

APPENDIX P

WATER LEVEL MEASUREMENTS AND GROUNDWATER ELEVATION DATA

Appendix P contains water level measurements collected fror [illegible] gauges in all watersheds at the Annex on 13 September and 3 December 19[illegible] with survey data, the water level measurements were used to calculate gr[illegible] s and hydraulic gradients, and to determine general and site-specific grour[illegible] Annex. All staff gauges were located in groundwater discharge areas. Mea[illegible] at these points are presumed to be surface representations of the grou[illegible] All water level measurements and groundwater elevations are presente[illegible]

Table P-1

SUDBURY ANNEX WATER LEVEL MEASUREMENTS AND GROUNDWATER ELEVATIONS

Site Name and Number	Monitoring Well or Staff Gauge	Ground Surface Elevation (feet AMSL)	09/13/93		12/03/93	
			Depth to Water (feet BGS)	Water Elevation (feet AMSL)	Depth to Water (feet BGS)	Water Elevation (feet AMSL)
Watershed 1A — Upper Taylor Brook						
A3	OHM-A3-A	187.60	6.11	181.49	5.26	182.34
	OHM-A3-3	186.40	4.51	181.89	3.75	182.65
	EHA6	191.90	9.85	182.05	5.40	186.50
	SG-14	NA	dry	<182.40	NA	182.40
	SG-15	NA	dry	<181.40	NA	181.40
A4	OHM-A4-4	203.30	14.47	188.83	12.14	191.16
	OHM-A4-5	190.10	8.01	182.09	7.00	183.10
	DM-4	193.10	8.41	184.69	6.44	186.66
	DM-5	200.20	11.03	189.23	8.33	191.87
	EHA7	199.60	NA	---	5.26	194.34
P6	OHM-P06-25	197.80	15.38	182.42	15.46	182.34
	OHM-P06-26	190.30	8.27	182.03	8.11	182.19
	OHM-P06-27	199.00	16.18	182.82	16.30	182.70
P43B	GZA-MW1	212.40	15.87	196.53	13.57	198.83
	GZA-MW3	202.80	NM	---	19.81	182.99
Watershed 1B — Lower Taylor Brook						
P45	GZA-MW2	196.20	10.49	185.71	9.70	186.50
	EHA-5	183.40	4.60	178.80	2.80	180.60
	DM-2	188.80	8.80	180.00	3.55	185.25
	DM-3	192.60	7.18	185.42	5.65	186.95
	SG-16	NSD	NA	<183.15	NA	<183.15
	SG-17	NSD	NA	<179.60	NA	<179.60
A2	EHA-4	194.50	8.48	186.02	5.43	189.07
	E3-A2-M01	195.51	11.30	184.21	10.35	185.16
P11	E3-P11-M01	199.97	6.32	193.65	5.20	194.77
	OHM-P11-32	201.30	7.49	193.67	6.24	195.06
	OHM-P11-33	200.40	6.73	192.90	5.46	194.94
	OHM-P11-34	204.30	11.40	193.53	10.34	193.96
	ATEC 1	NSD	NM	---	5.91*	---
	ATEC 2	NSD	NM	---	5.56*	---
	EHA3	208.00	NM	---	11.58	196.42
P13	E3-P13-M01	208.00	12.71	195.29	13.09	194.51
	E3-P13-M02	196.65	2.15	194.50	0.03	196.62
	E3-P13-M03	200.03	2.69	197.34	1.94	198.09
	E3-P13-M04	200.27	6.50	193.77	5.52	194.75
	SG-3	NSD	NA	<189.39	NA	189.39
	SG-4	NSD	NA	<185.35	NA	<185.35
	SG-9	NSD	NA	<196.50	NA	<196.50
	SG-18	NSD	NA	<197.15	NA	<197.15
P23	E3-P23-M01	195.86	12.02	183.84	11.27	184.59
P26	E3-P26-M01	196.44	5.96	190.48	5.11	191.33
	E3-P26-M02	195.22	5.94	189.28	5.74	189.48
	E3-P26-M03	194.54	5.55	188.99	5.85	188.68

Table P-1

SUDBURY ANNEX WATER LEVEL MEASUREMENTS AND GROUNDWATER ELEVATIONS

Site Name and Number	Monitoring Well or Staff Gauge	Ground Surface Elevation (feet AMSL)	09/13/93		12/03/93	
			Depth to Water (feet BGS)	Water Elevation (feet AMSL)	Depth to Water (feet BGS)	Water Elevation (feet AMSL)
Watershed 2 — Hop Brook						
A10	E3-A10-M01	198.45	12.20	186.25	NM	---
	OHM-A10-19	200.40	13.57	186.83	13.36	187.04
	OHM-A10-20	197.10	10.66	186.44	10.38	186.72
	DM1	198.90	12.29	186.61	12.11	186.79
	DM7	199.40	12.69	186.71	12.55	186.85
	DM11	198.30	11.63	186.77	13.50	184.80
A11	OHM-A11-21	187.40	7.40	180.00	7.20	180.20
	OHM-A11-22	188.50*	9.43*	179.07	8.96*	179.54
	OHM-A11-23	193.90	9.32	184.58	9.20	184.70
	SG-20	NSD	NA	<186.05	NA	<186.05
P36	E3-P36-M01	210.09	14.60	195.49	14.36	195.73
	E3-P36-M02	196.86	11.77	185.09	10.27	186.59
	E3-P36-M03	191.44	14.19	177.25	13.87	177.57
	SG-19	NSD	NA	<174.90	NA	<174.90
P37	E3-P37-M01	193.90	11.54	182.36	11.92	181.98
	E3-P37-M02	191.04	14.11	176.93	14.05	176.99
	E3-P37-M03	189.45	14.30	175.15	16.21	173.24
	OHM-BW-1	190.10	16.91	173.19	17.38	172.78
P48	OHM-P48-41	196.10	8.90	187.20	8.30	187.80
	OHM-P48-42	197.10	9.82	187.28	9.29	187.81
	OHM-P48-43	198.00	10.60	187.40	10.10	187.90
	OHM-BW-2	197.40	10.16	187.24	9.73	187.67
Watershed 3 — Lower Assabet River						
A7	EHA2	205.60	23.06	182.54	20.36	185.24
	OHM-A7-7A	209.60	dry	<196.81	dry	<196.81
	OHM-A7-8	204.30	13.16	191.14	6.37	197.93
	OHM-A7-9	184.30	8.06	176.24	6.71	177.59
	OHM-A7-10	179.60	3.39	176.21	2.49	177.11
	OHM-A7-11	179.70	artesian	>179.70	artesian	>179.70
	OHM-A7-12	185.20	8.67	176.53	7.20	178.00
	OHM-A7-13	231.50	14.65	216.85	5.79	225.71
	OHM-A7-45	207.90	15.96	191.94	12.70	195.20
	OHM-A7-46	208.90	dry	<199.00	6.50	202.40
	OHM-A7-51	NSD	NM	---	8.62*	---
	OHM-A7-52	NSD	NM	---	5.76*	---
	SG-6	NSD	NA	<176.90	NA	<176.90
A8	OHM-A8-14	209.40	17.18	192.22	18.20	191.20
	OHM-A8-15	206.70	15.53	191.17	16.00	190.70
A9	OHM-A9-16	212.50	20.40	192.10	21.01	191.49
	OHM-A9-17	210.80	26.57	184.23	26.95	183.85
	OHM-A9-18	210.90	26.11	184.79	26.77	184.13
	OHM-A9-47	211.10	22.30	188.80	23.74	187.36
	OHM-A9-49	212.80	19.97	192.83	dry	<192.83
	DM8	211.00	28.63	182.37	29.49	181.51
	DM9A	211.20	26.57	184.63	27.87	183.33
	DM10	210.70	21.82	188.88	23.31	187.39
P57	E3-P57-M01	201.71	10.26	191.45	9.73	191.98

Table P-1						
SUDBURY ANNEX WATER LEVEL MEASUREMENTS AND GROUNDWATER ELEVATIONS						
Site Name and Number	Monitoring Well or Staff Gauge	Ground Surface Elevation (feet AMSL)	09/13/93		12/03/93	
			Depth to Water (feet BGS)	Water Elevation (feet AMSL)	Depth to Water (feet BGS)	Water Elevation (feet AMSL)
Watershed 4 — Upper Assabet River						
A6	E3-A06-M01	206.86	15.83	191.03	14.29	192.57
	SG-7	NSD	NA	<197.60	NA	<197.60
P22	E3-P22-M01	188.15	4.84	183.31	6.60	181.55
Watershed 5 — Lake Boon						
A5	E3-A5-M01	201.47	7.70	193.77	9.72	191.75
	OHM-A5-24	205.70	9.90	195.80	9.60	196.10
	OHM-A5-44	203.30	7.23	196.07	6.72	196.58
	DM-6	204.80	8.87	195.93	8.47	196.33
	SG-1	NSD	NA	<192.90	NA	<192.90
P7	OHM-P7-28	202.20	10.92	191.28	10.96	191.24
	OHM-P7-30	198.00	6.92	191.08	6.37	191.63
	OHM-P7-31	200.90	9.49	191.41	10.01	190.89
P31	E3-P31-M01	192.25	7.14	185.11	NM	---
P40	OHM-P40-29	206.10	12.57	193.53	12.40	193.70
	OHM-P40-38	205.20	10.78	194.42	10.83	194.37
	OHM-P40-39	206.90	12.27	194.63	12.38	194.52
	EHA1	204.20	9.69	194.51	9.65	194.55
P58	E3-P58-M01	191.85	7.04	184.81	NM	---
	E3-P58-M02	191.43	6.69	184.74	NM	---
	OHM-BW-4	206.20	15.83	190.37	NM	---
	SG-10	NSD	NA	<198.75	NM	<198.75
Watershed 6 — Willis Pond and Crystal Lake						
P1	ATEC P1/P3	NSD	NM	---	13.55*	---
P2	E3-P2-M01	202.00	12.43	189.57	12.53	189.47
P3	E3-P3-M01	258.32	35.55	222.77	NM	---
	E3-P3-M02	216.09	8.43	207.66	dry	---
	SG-11	NSD	NA	<182.91	NA	182.91
	SG-12	NSD	NA	<183.45	NA	183.53

Legend:

AMSL = Above Mean Sea Level
BGS = Below Ground Surface
NSD = No Survey Data
NA = Not Applicable
NM = Not Measured
* = Measurement from top of inner casing.

Source: Ecology and Environment, Inc. 1994.